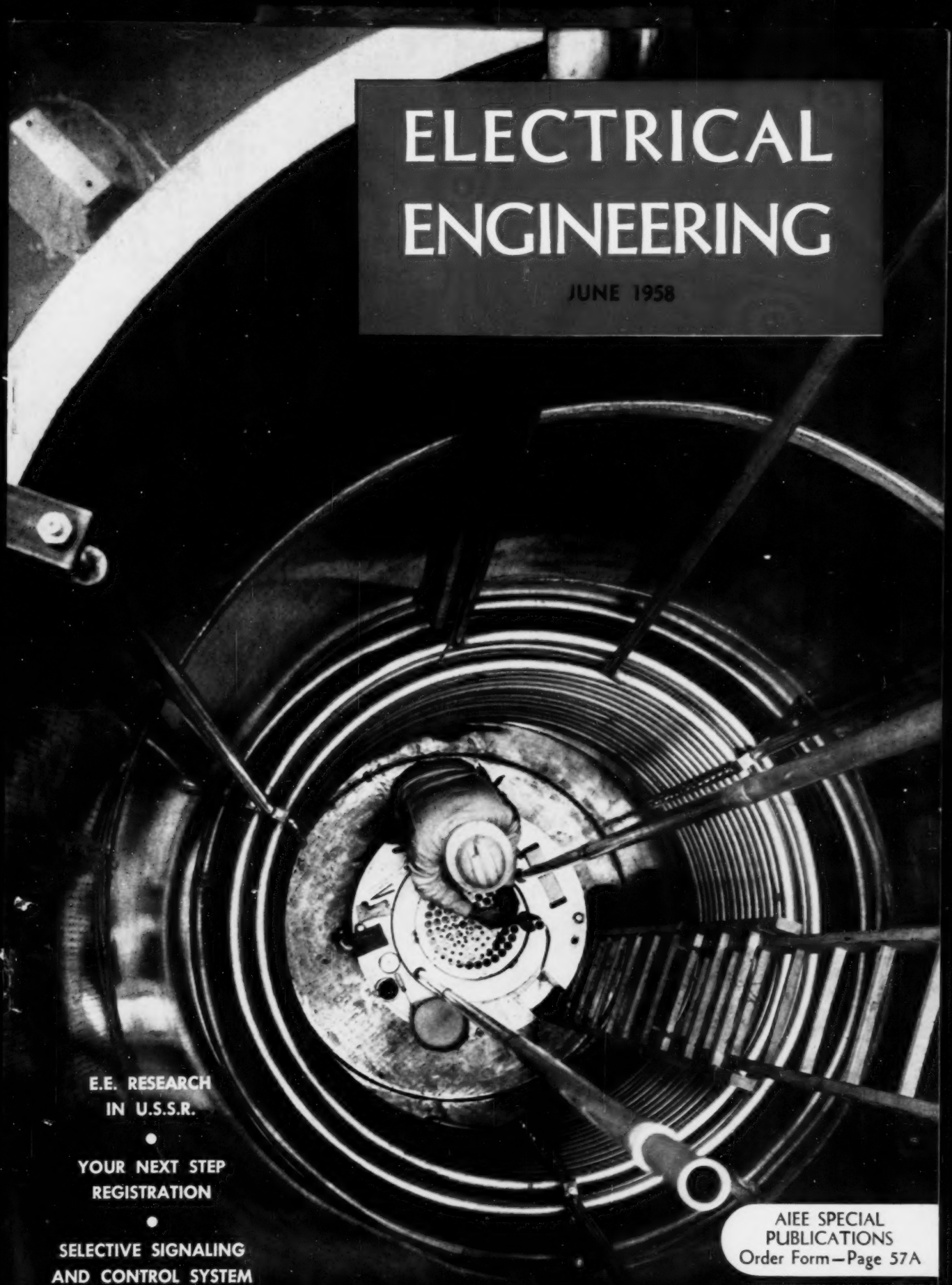
ELECTRICAL ENGINEERING

JUNE 1958



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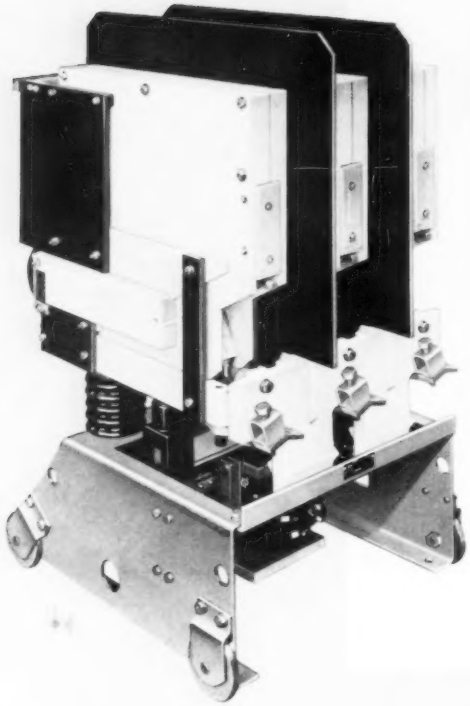
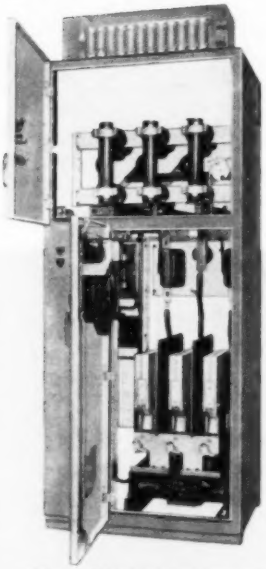


Air break starters

for high voltage motors

A-B QUALITY



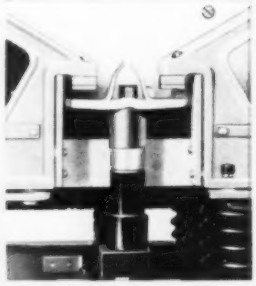
Bulletin 966 high voltage air break, across-the-line synchronous motor starter in NEMA Type 1 enclosure.

This *new* air break contactor—around which Allen-Bradley has developed a complete line of high voltage starters—is designed to match your *toughest* applications. It features the same solenoid design—with only *one* moving part—that has made Allen-Bradley low voltage starters universally recognized for their tremendous operating life.

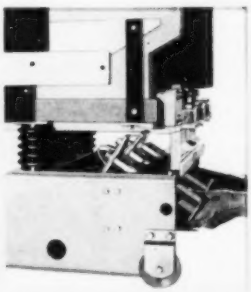
These new contactors are available in full voltage and reduced voltage starters—nonreversing or reversing—for squirrel cage, part winding, slip ring, and synchronous motors up to 1500 hp, 2300 volts; 2500 hp, 4600 volts. All starters are equipped with current limiting fuses and have an interrupting capacity of 150,000 kva at 2300 volts and 250,000 kva at 4600 volts.

It will pay you to investigate these *quality* starters. Complete information is contained in Publication 6080 . . . please send for your copy, today.

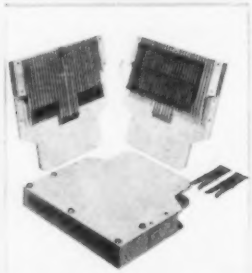
Only One Moving Part. Simple solenoid design eliminates trouble-causing pins, pivots, and flexible jumpers.



Double Break Contacts of silver alloy never need maintenance. Vertical motion assures uniform contact pressures.



Easy Access from Front. Crossbar and contacts removable from front, without special tools, for easy inspection.



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ELECTRICAL ENGINEERING

JUNE 1958
Vol. 77, No. 6

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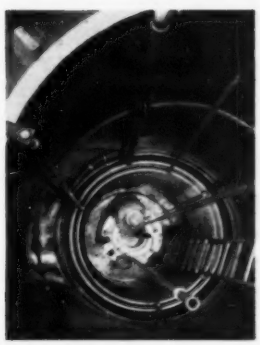

THE COVER: Scientist positions a control rod guide tube in the reactor core grid plate of General Atomic Division of General Dynamics Corporation's prototype, 10-kw TRIGA reactor at the University of Arizona at Tucson, first educational institution in the world to have the newly developed, multipurpose, inherently safe unit. Story appears on page 569.

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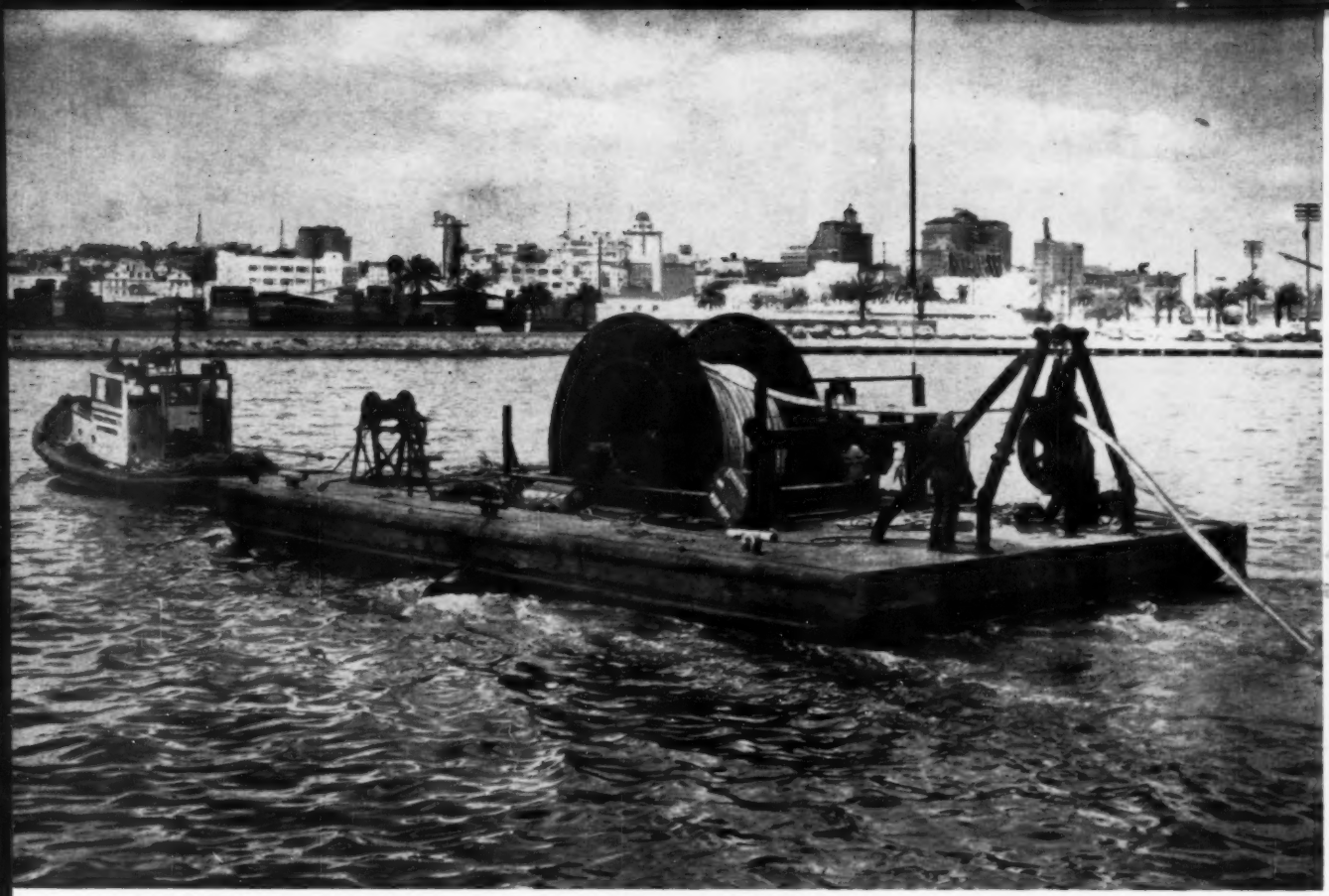

12kv giant goes under. San Diego Gas & Electric installed this 3,900-foot submarine cable across San Diego Bay in a fast and trouble-free operation. The new 12kv, 3/c, 500,000 CM cable is 4½ inches in diameter with Okolite rubber insulation, copper shielding tapes and steel armor.

Cable laying time: **half an hour flat!**

Okolite used for pre-tested dependability

The problem was to obtain maximum dependability in the new submarine cable laid under San Diego Bay to handle increased power needs in the busy Coronado area. In submarine cable, of course, dependability is doubly important with the rough service cable gets and the complicated and expensive operation required to lay a cable or remove it in case of trouble.

To insure this dependability, engineers from San Diego Gas and Electric chose pre-tested Okolite-insulated cable . . . and took advantage of three sound standards for evaluating anticipated cable service:

1. Time—High-voltage Okolite-insulated cables have a service record of more than 30 years . . . on land as well as in tough, underwater services, where a case of trouble can run into thousands of dollars.

2. Engineering—Okonite engineers' know-how pays off in every stage of cable purchase and installation: from designing the best construction possible to speeding installation, as in San Diego's case, with Okonite-designed reel frames, lifting beams and other cable-handling equipment.

3. Inch-by-Inch Inspection—Okonite now provides built-in life insurance for every strip-insulated, high-voltage cable through the use of its exclusive development, the "Gooding Test Train." This electronic testing equipment, which scans every inch of the cable, can pick out the most minute imperfection—impossible to detect by any standard test method—that might shorten cable life after it's placed in service.

These are three good reasons for *you* to specify Okolite for *your* vital high-voltage circuits. Whatever your cable needs, when you talk to Okonite, you get unprejudiced recommendations because Okonite, and *only* Okonite, makes cable by all four insulating methods: strip . . . dip . . . extrusion . . . taping. The Okonite Company, Passaic, New Jersey.

***where there's electrical power . . . there's* OKONITE CABLE**

5479

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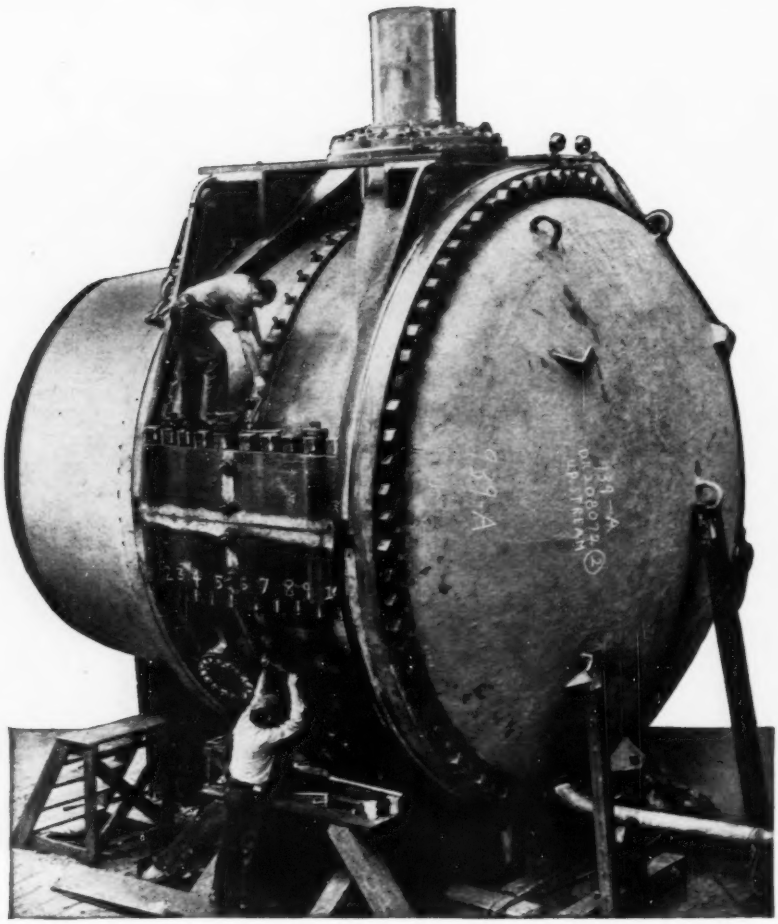

This 16-Foot Butterfly Valve Illustrates the type of work which Newport News takes in stride. Newport News built 3 such valves, each weighing 446,000 lbs., for the Ross Power Plant, Skagit Project, Department of Light, City of Seattle, Washington. Designed for a water flow of 3,620 cu. ft. per sec., and a hydrostatic pressure of 290 psi., these valves were shop tested by Newport News at 450 psi. They are hydraulically operated with oil at 1,500 psi. pressure. Shop tests assure speedy, trouble-free assembly of Newport News built equipment, on the site.

The TEST of a TITAN

Here is one of the largest high head butterfly valves ever built, undergoing a shop test at Newport News. If you had an opportunity to follow this unit from start to finish, you would see *first hand* how Newport News produces massive equipment *economically*. For economy is a basic advantage that results from Newport News' high integration of skill and production facilities.

Large engineering and technical staffs, operating a plant comprising acres of brass, iron and steel foundries, five huge machine shops and other extensive fabricating facilities, have made Newport News one of the world's largest producers of hydraulic turbines, valves, gates, penstocks and other essential equipment... both standard and special in design.

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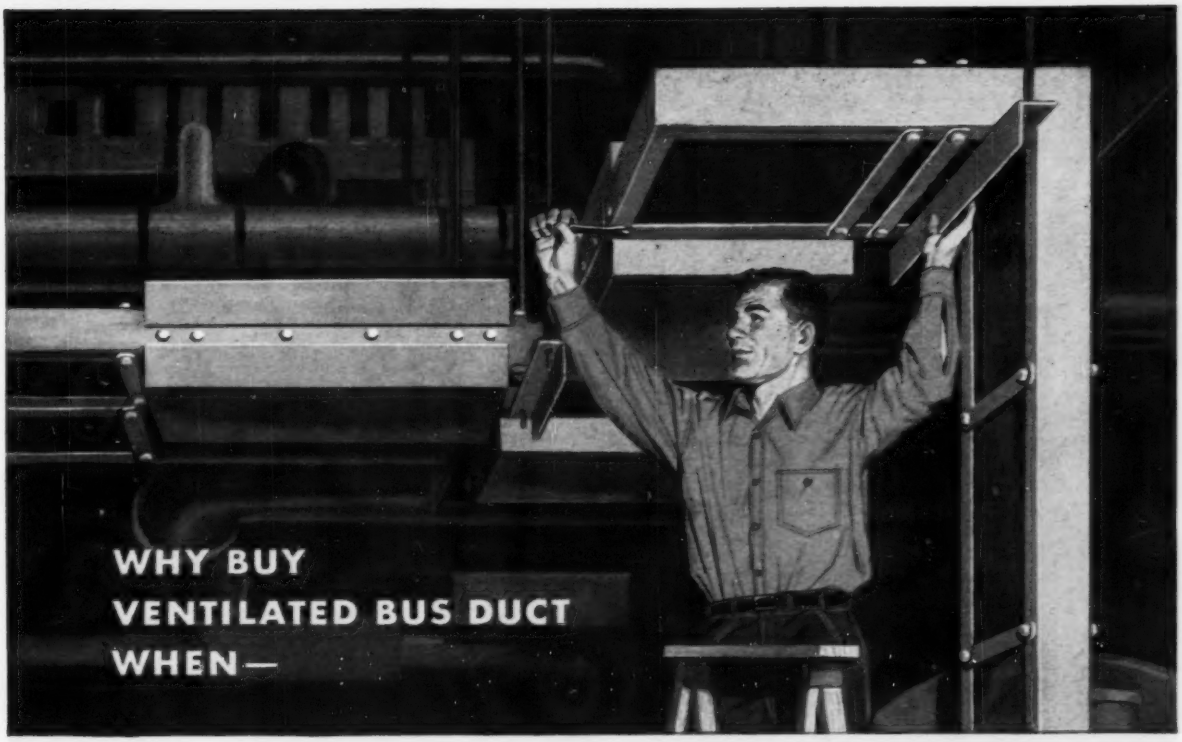

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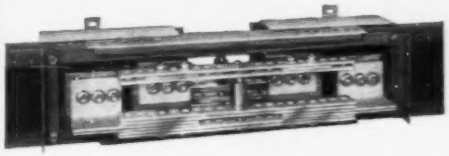
mounts in any position without de-rating
—*and costs no more*

*(low impedance)

Square D totally enclosed low-impedance bus duct mounts in any position without de-rating, because it doesn't need ventilation. Moreover, you can have all the advantages of totally enclosed duct without the price penalty of a "special," because all Square D low-impedance bus duct is totally enclosed. Square D feed-in duct has no ventilation holes, is protected from physical damage and dust accumulation. It's smaller than ventilated duct by as much as 50%. Doesn't it make sense, when buying low-impedance duct, to specify a product that meets every one of your requirements? Square D totally enclosed low-impedance duct costs no more —why settle for less?

How Square D
TELESCOPIC JOINTS
provide simpler installation



Each run of Square D totally enclosed aluminum feed-in duct is equipped with one telescopic joint. Because these joints are infinitely adjustable from 0 to 12 inches, they provide complete flexibility when installed in the plant. Any last-minute layout changes can be corrected on the spot. No need for ordering "specials" with resulting long delivery. Telescopic elbows, with a 6-inch adjustment in either the flat or edgewise position, are also in stock.

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But it could have been rolling in seconds or minutes! If only the circuitry had been arranged on the modular basis so that essential elements of the automatic control and operating system could be disconnected quickly . . . and complete, operable spare components inserted at a moment's notice. The units in trouble could have been repaired properly, too, at leisure . . . by trained personnel, at the right place, with the right facilities. Production could have gone on . . . thousands of man-hours and thousands of dollars saved . . . merely by the use of quick-disconnect components.

Are the controls in your electrical or electronic product designed on the modular basis? How about your production line? Will minor failure cause breakdown? Or do you need Cannon Connectors? Cannon makes over 27,000 different electrical connectors. If one of these does not meet your requirements, we'll design and make the electrical connector you need. Write today! Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. Please refer to Dept. **117.**

Send for explanatory material on how modular designs can save dollars.

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Where Reliability for Your Product is Our Constant Goal

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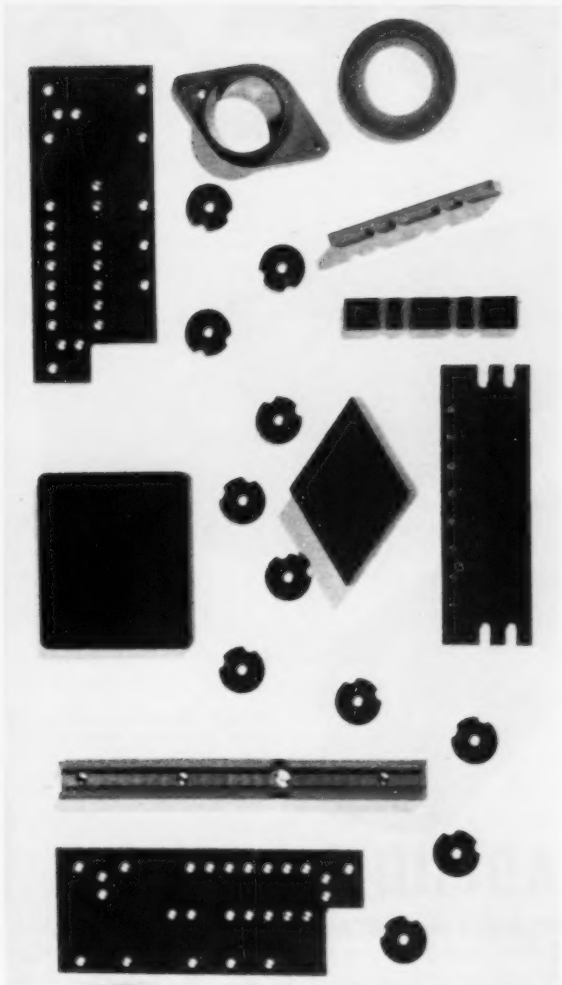

Fabricated by CDF. Near the presses that produced the Dilecto laminates, these paper-base parts were machined to close tolerances by CDF specialists . . . quickly, accurately, economically for the purchasers. This is a random selection from the five grades described in the table below.

CDF Dilecto® paper-base laminates for the workhorse insulation jobs

For everyday mechanical-electrical parts that receive tough punishment and must have excellent physical and dielectric properties at low cost, the CDF phenolic paper-base line is outstanding.

Economy. CDF paper-base grades machine readily into intricate parts. Some are flame-retardant. Others are especially adaptable for punching. All are economical for the value delivered.

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See Sweet's, Electronics Buyers' Guide, and the other directories for the phone number of the CDF sales engineer nearest you. Or send us your print or problem direct, and we'll return a recommendation of the right Dilecto grade for your need.

CDF makes Di-Clad* printed-circuit laminates, Diamond* Vulcanized Fibre, CDF products of Teflon†, flexible insulating tapes, Dilecto* laminated plastics, Celoron* molded products, Micabond* mica products, Spiral Tubing, Vulcoid*.

*Trademark of Continental-Diamond Fibre Corporation
†Du Pont trademark for its TFE-fluorocarbon resin

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Typical Property Values—Dilecto Paper-Base Laminates in Sheet Form

	X-13 (NEMA X)	XP-13 (NEMA P)	XX-13 (NEMA XX)	XX-13 FR (Fire-retardant) (NEMA XX)	XXXP-28 (NEMA XXXP)
ROCKWELL HARDNESS	100	95	110	108	90
TENSILE STRENGTH lw (1000 psi.)	20	12	16	17	12
FLEXURAL STRENGTH lw (1000 psi.)	27	16	17	20	18
COMPRESSIVE STRENGTH (1000 psi.)	40	25	35	41	22
WATER ABSORPTION (% in 24 hrs.) 1/16" thickness	3.5	3.0	1.4	1.2	0.6
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (°C.)	120	120	120	120	120
DIELECTRIC STRENGTH perp. to lam. (VPM)	800	800	650	700	800
DIELECTRIC STRENGTH parallel to lam. (Kv.)	50	50	60	70	75
DISSIPATION FACTOR at 1 mc, Cond. A	0.042	0.038	0.034	0.038	0.027
DIELECTRIC CONSTANT at 1 mc, Cond. A	5.5	4.6	4.7	4.8	3.6
ARC-RESISTANCE (seconds)	8	4	4	10	10
INSULATION RESISTANCE (megohms) ASTM D-257, Fig. 3	100	100	1,000	1,000	600,000
AIEE insulation class	A	A	A	A	A

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WRITE FOR COMPLETE INFORMATION

1948—*Early "point contact" transistor.*

The remarkable transistor observes its 10th birthday

In 1948, Bell Telephone Laboratories announced the invention of the transistor. In 1958, the transistor provided the radio voice for the first United States satellite.

To advance the transistor to its high level of usefulness, Bell Labs had solved problems which, in themselves, approached the invention of the transistor itself in scientific achievement.

First, there had to be germanium of flawless structure and unprecedented purity. This was obtained by growing large single crystals—and creating the "zone refining" technique to purify them to one harmful part in *ten billion*.

The "junction" transistor, another radical advance, spurred transistor use. Easier to design, lower in noise, higher in gain and efficiency, it became the heart of the new electronics.

An ingenious technique for diffusing a microscopically thin layer on semiconductors was created. The resulting "diffused base" transistor, a versatile broadband amplifier, made possible the wide use of transistorized circuits in telephony, FM, TV, computers and missiles.

In telephony the transistor began its career in the Direct Distance Dialing system which sends called telephone numbers from one exchange to another.

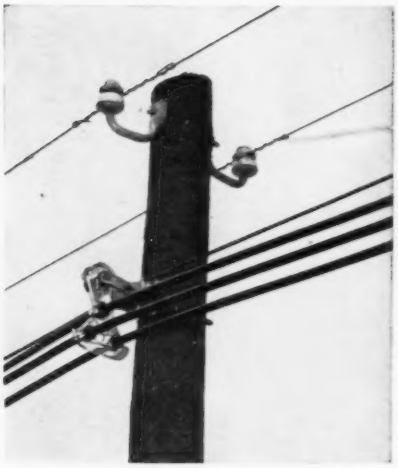
For Bell System communications, the transistor has made possible advances which would have been impossible or impractical a brief decade ago.

1958—*Satellite transistor, incorporating 10 years of Bell Labs research and development.*

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

New Roeclamp with Roeplastic® Cable Costs 60% Less than Self-Supporting Cables, Minimizes Tree Problems, Installs with Ease, Looks Better!*



New Roebling ROEPLASTIC Cable with ROECLAMP requires only one foot of clearance through trees! Note improved, compact appearance. No crossarms are needed.

Designed for 5kv systems (2400/4160Y and 4800 v delta) and 8kv systems (4800/8320Y and 7200 v delta), the Roebling Aerial Spaced Cable actually costs 60% less than conventional self-supporting cables. It provides a neat, compact appearance, improved voltage regulation, higher current-carrying capacity, and positive phase identification.

Up to three conductors can be carried by ROECLAMPS, which are suspended from a strong messenger. The messenger also provides protection against lightning and falling limbs.

Aluminum conductors come in 17 standard sizes and strand constructions, and are made with a greater number of finer strands for extra flexibility. Standard insulation is extruded ROEPLASTIC P-11R7 (other extruded insulations available). ROECLAMPS come complete with grommets to fit cables and messenger you order.

Ask your Roebling representative to show you the remarkable new ROECLAMP. He'll tell you more, too, about the unusual savings and improvements you can effect, or write Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

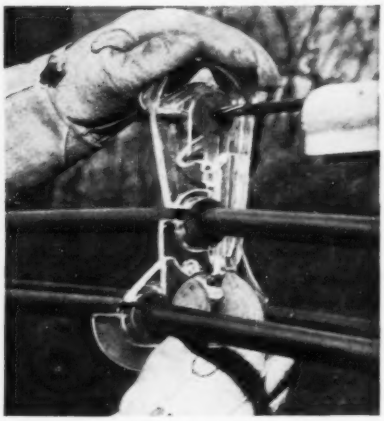
ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

Roeclamp has unit construction... installs in seconds—without tools!

One motion and ROECLAMP is on messenger and ready to receive conductors. Phase changes and repairs do not necessitate removal of clamp. ROECLAMP comes complete with grommets to fit messenger and conductors you order.

Note how easily conductors drop into place. Installation is measured in seconds, even with "boxing gloves" on. ROECLAMP is Plexiglas†, tests to over 1000-lb. breaking strength, offers outstanding weather resistance, best possible electrical properties.



35 ROECLAMPS are required every 1000 feet. Installation is completed by hand-tightening of nut. Not even a screw driver is required!

*Pat. pending
†Reg. T.M.—Rohm & Haas Co.

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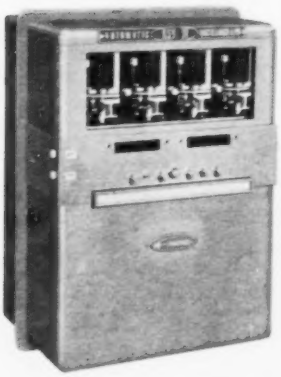

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new symmetrical interrupting ratings for XS Cutouts adjust lab results to field conditions

S&C matches actual ratings to system short-circuit calculations—

To simplify application, S&C has now provided symmetrical ratings for its distribution cutouts.

These new symmetrical ratings are provided because asymmetrical ratings are based on total available short-circuit current of the circuit, including the DC component. The asymmetrical ratings furnish a uniform, standardized measure of cutout performance, but they cannot, of course, be used directly in matching cutouts to system short-circuit calculations which yield *symmetrical* values.

The new symmetrical ratings bridge the gap and eliminate the possibility of "underprotecting" the system with a cutout of inadequate interrupting capacity, or "overprotecting" with a cutout of unnecessarily high interrupting capacity.

To arrive at a nominal set of symmetrical ratings, specific X/R ratios are assumed for the Heavy Duty XS and the Extra Heavy Duty XS,—8 and 12 respectively—typical of the conditions at locations where each of these cutouts is applied (see table at right).

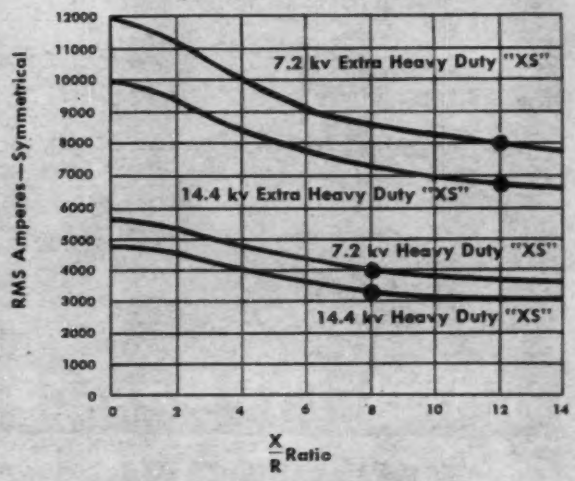
To enable the distribution engineer to take advantage of more favorable conditions—that is, where the X/R may be lower—special adjustment curves (shown to the right) are provided. These curves indicate the symmetrical interrupting ratings of the XS at other X/R ratios. (Those at 0 are the *actual* asymmetrical interrupting capacities of the XS, which may differ from the *nominal* asymmetrical ratings per NEMA standards.)

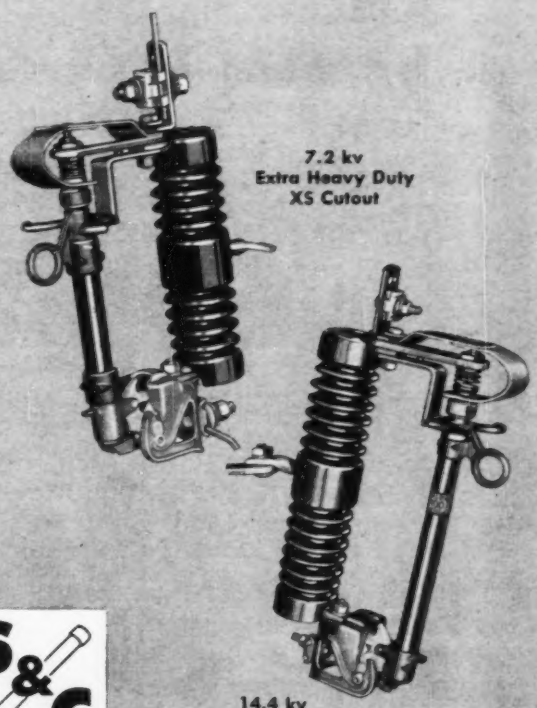
For further information, write for Descriptive Bulletin 511—providing full data on the XS Cutout—to S&C Electric Company, 4427 Ravenswood Ave., Chicago 40, Ill. In Canada: S&C Electric Canada, Ltd., 8 Vansco Road, Toronto 14, Ontario.

50/60 Cycle Short-Circuit "Nominal" Interrupting Ratings

Nominal Ratings kv	Amperes, RMS			
	Heavy Duty "XS"		Extra Heavy Duty "XS"	
	Asymmetrical	Symmetrical	Asymmetrical	Symmetrical
7.2	5000	4000	12000	8000
14.4	4000	3300	10000	6700

Adjustment Curves for Symmetrical Interrupting Ratings of XS Cutouts at various X/R Ratios.





7.2 kv Extra Heavy Duty XS Cutout

14.4 kv Heavy Duty XS Cutout

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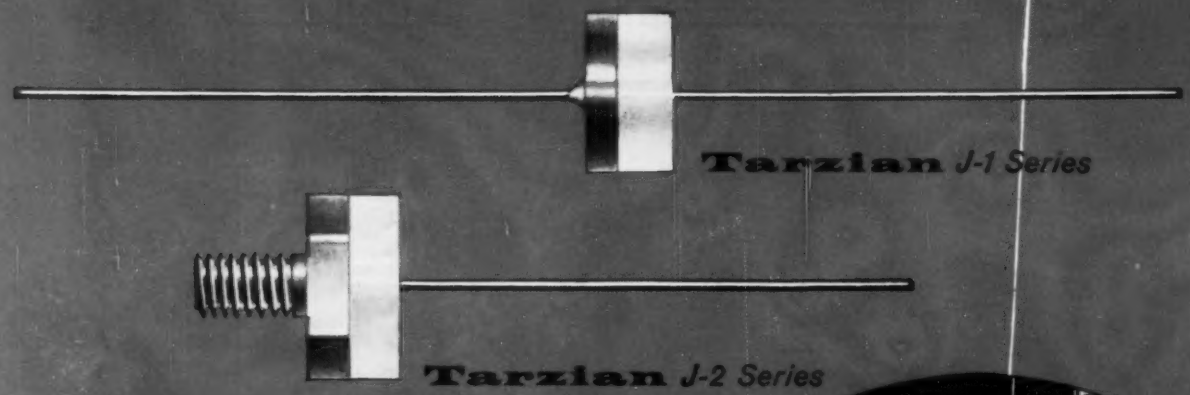

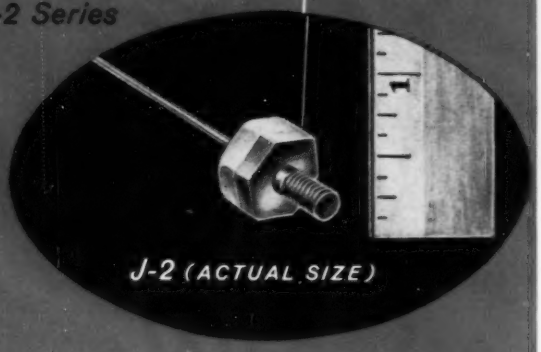

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- *Low Forward Drop*
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Another result of continuous *PROGRESSIVE* research and development at Tarzian's, the J series Silicon Rectifiers offer a wide range of ratings. Small size and low, low cost allow the use of this series in even the most competitive applications. Let competent Tarzian power conversion engineers consider your application or send for additional information.

SPECIFICATIONS

J1 Electrical Ratings

S. T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes: Max. D. C. Load 100° C	Max. Recurrent Peak 100° C	Surge 4MS Max. 100° C	Jetec No.
10J1	100	70	1.5	10	60	1N1617
20J1	200	140	1.5	10	60	1N1618
30J1	300	210	1.5	10	60	1N1619
40J1	400	280	1.5	10	60	1N1620

For capacitive motor or battery loads, derate d.c. current by 20%

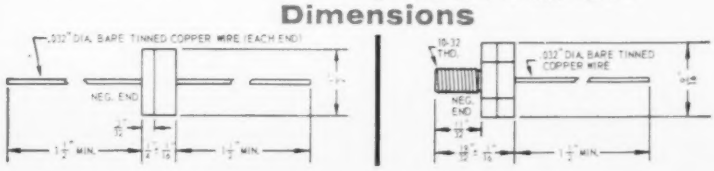
J2 Electrical Ratings*

S. T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes: Max. D. C. Load 100° C	Max. Recurrent Peak 100° C	Surge 4MS Max. 100° C	Jetec No.
10J2	100	70	10	50	80	1N1621
20J2	200	140	10	50	80	1N1622
30J2	300	210	10	50	80	1N1623
40J2	400	280	10	50	80	1N1624

For capacitive motor or battery loads, derate d.c. current by 20%

* with 5" x 5" x 1/16" copper heat sink

Dimensions



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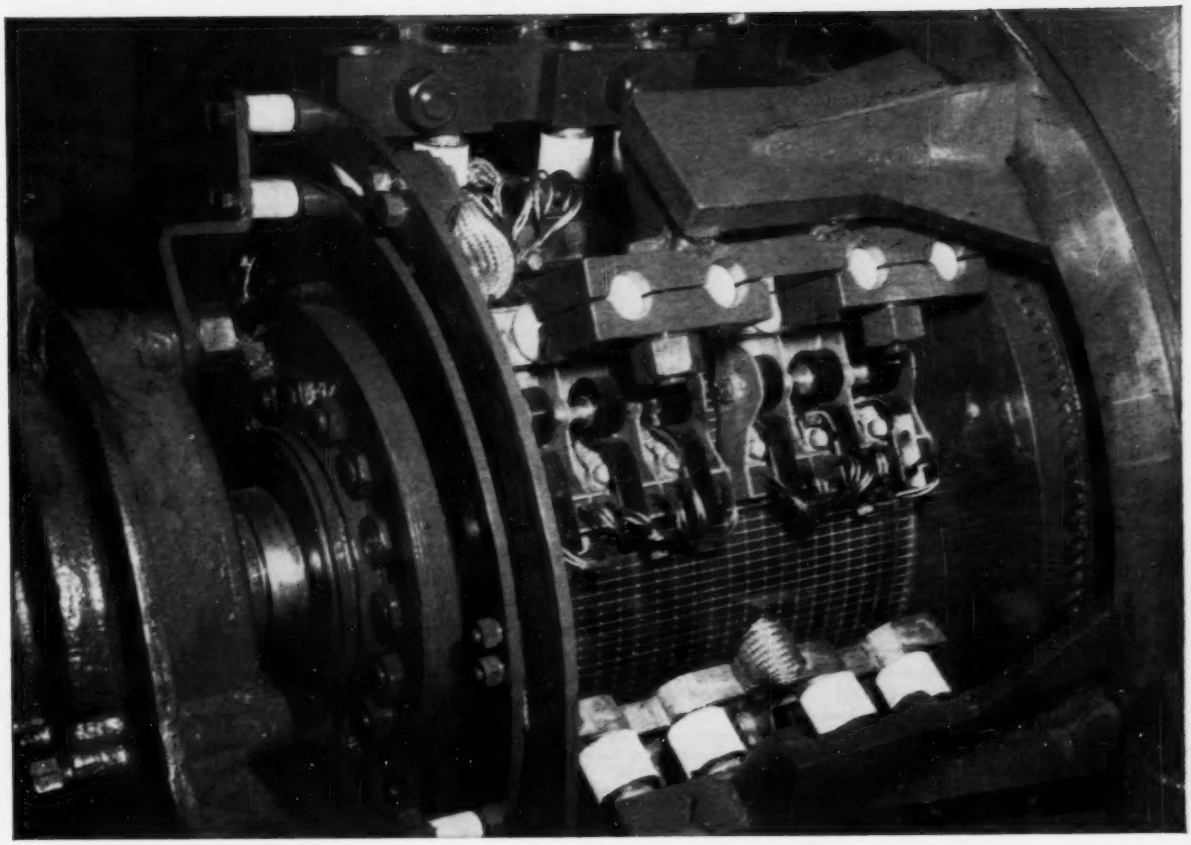

NATIONAL 'Improvement' Saved This Motor from the Scrap Heap

The motor shown above is one of three which powered bridge cranes on an ore unloading dock. After years of operation it was obvious that these motors had reached the point where complete rebuilding would be required to insure continued service.

The motor manufacturer considered the design obsolete and replacement parts were not available. But to replace the motors would have been extremely expensive. Not only would new motors have been required, but the existing crane structure would have had to be modified to accommodate them.

National undertook not merely to repair the motors but to redesign and modernize them. Work done included:

1. design and manufacture of new commutators
2. design and winding of new heavy duty fields
3. rewinding of the armatures
4. design and construction of more rugged brush holders and brush rigging.

As a result of National "repair and improvement", the motors were made more efficient in their performance and less costly to operate and maintain. The peak current demand of the redesigned units is on the order of 6000 amperes as compared to 8000 ampere peaks before rebuilding. And practically all of the parts now required for maintenance are standard stock items.

This case is typical of National repair service. Improvement, not merely repair, is always the objective. For details on how National redesign ingenuity can help *you* solve your tough electrical maintenance problems, just call your nearby National field engineer or drop us a line.

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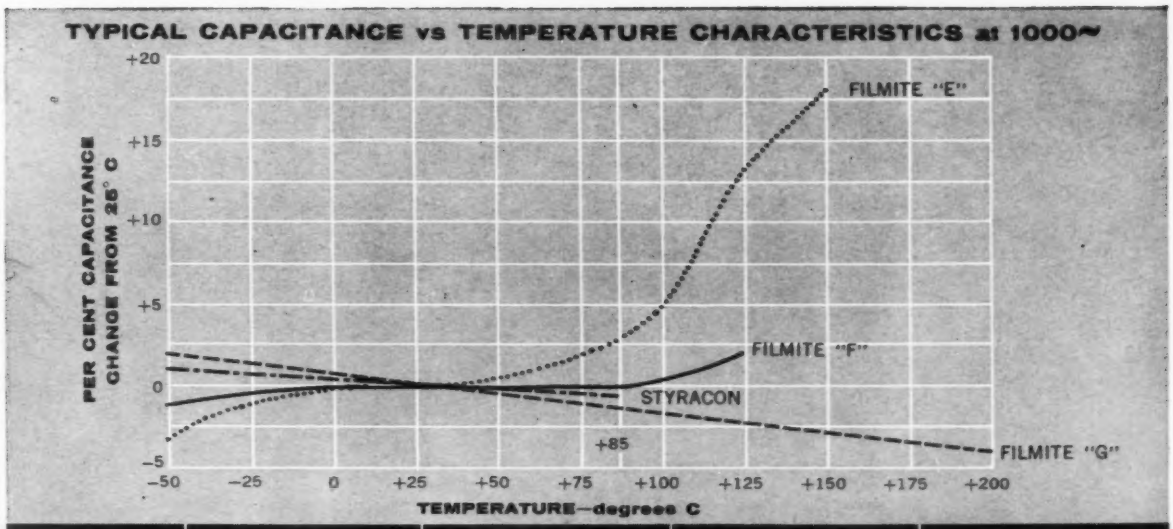

	STYRACON (85°C)	FILMITE "E" (150°C)	FILMITE "F" (125°C)	FILMITE "G" (200°C)
RATINGS	.001 to 1.00 μF 50 to 600 WVDC	.001 to 1.00 μF 200 to 2500 WVDC	.001 to 1.00 μF 200 to 600 WVDC	.001 to 1.00 μF 200 to 600 WVDC
STYLES	tubular metal cases screw-neck cases drawn metal cases	tubular metal cases screw-neck cases	tubular metal cases screw-neck cases "bathtub" cases	tubular metal cases screw-neck cases drawn oval cases
WRITE FOR TECHNICAL DATA	Engineering Bulletin No. 2510	Engineering Bulletin No. 2410	Engineering Bulletin No. 2560	Engineering Bulletin No. 2610

4 kinds of film dielectric capacitors

for specialized applications

Here are four plastic-film dielectric capacitors now in regular production at Sprague:

STYRACON CAPACITORS find wide application in laboratory equipment and in industrial controls where their low dielectric hysteresis (low "soak"), high insulation resistance, high "Q", low and linear temperature coefficient of capacitance are of great value.

FILMITE "E" CAPACITORS are general-purpose capacitors for use up to 150°C where capacitance stability with temperature is of secondary importance. They are also used at lower temperatures where very high insulation resistance is a prime requirement.

FILMITE "F" CAPACITORS are intended for use in circuits where the absolute minimum in capacitance change with temperature is a must and relatively large capacitance values are used. These capacitors typically will be within .05% of their 25°C value from −10°C to +85°C. They may be used up to 125°C where greater capacitance excursion is tolerable.

FILMITE "G" CAPACITORS have the highest temperature rating of any organic dielectric. They may be used up to 200°C! All units are nickel-plated to withstand high temperature corrosion. They also have the highest insulation resistance, the lowest dielectric hysteresis, and the lowest dissipation factor of any capacitor made so that they are often used at lower temperatures which are above the 85°C limit of the lower-cost Styracon Capacitors.

CAPACITANCE VS. TEMPERATURE CHARACTERISTICS of all four types of film capacitors are compared in the chart above for the benefit of the circuit designer.

ALL SPRAGUE FILM CAPACITORS are designed to have positive electrical contact between leads and electrodes, even at low operating voltages.

WRITE FOR ENGINEERING BULLETINS on the Sprague plastic-film capacitors in which you're interested. Address your letter to Sprague Electric Co., Technical Literature Section, 321 Marshall Street, North Adams, Mass.

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Electrical Engineering Education and Research in the USSR

P. A. ABETTI
MEMBER AIEE

G. F. LINCKS
FELLOW AIEE

In this second and concluding article, the authors survey the research facilities and note the extreme importance the USSR places on electrical engineering research and scientific education of the populace as a whole.

Part II—Research

ELECTRICAL ENGINEERING has always had a prominent place in the Soviet economy. One of Lenin's most famous savings is reproduced (Fig. 1) on the first page of the best-known Russian electrical engineering journal, *Electricity* (*Elektrichestvo*): "Bolshevism is the power of the Soviets, plus electrification of the whole country." The electrical engineering tradition in Russia goes back to the second half of the 19th Century, when Russian scientists and engineers made important contributions to the electrical art. Apparently contemporary Soviet electrical engineers are very proud of this tradition, as may be seen (Fig. 1) from the statement to the left of the title *Elektrichestvo* "Journal founded in the year 1880" (as a comparison, the AIEE *Transactions* and *Electrical Engineering* go back to 1884) and from the frequent articles in the same journal devoted to Russian electrical pioneers. Thus, Soviet electrical engineers are reminded every month of the political significance of their work and the importance attributed to it by the leaders of the Communist Party. Before World War II, Soviet electrical engineering was well behind its counterparts in this and Western European countries, but tremendous advances have been made in the last 10 years. The Soviet Union was the second country to achieve long-distance transmission of electric power at 400 kv, the highest voltage presently used in the world. (The Swedish 400-kv system was energized in 1952, the Soviet in 1956, the German and French about the end of 1957.) It was recently decided to raise the voltage of the USSR extrahigh-voltage (ehv) system from 400 to 500 kv. Thus, probably by 1959, the USSR will have operating a-c lines at the highest voltage in the world. The engineers at the International Electrotechnical Commission (IEC) meeting were impressed particularly by the amount and quality of the effort expended in the fields of electrical engineering education and research. Some even expressed concern that the USSR would soon be ahead of the United States and Western Europe in certain branches of the art. There is no doubt that the Soviet Union will have numerous technological firsts in the years ahead.

Because of the key importance of electric power in the national economies of the United States, of the Soviet Union, and of Western Europe, it is important to assess not only the present relative status but the relative future development of electric power in these countries. These developments will be profoundly affected by the present amount, quality, and over-all character of the effort being expended, here and abroad, in the fields of electrical engineering education and research.

ORGANIZATION

SCIENTIFIC AND ENGINEERING RESEARCH is considered just as important in the USSR as is electrical engineering education.[3] In addition to the academic institutions, there are a large number of research institutes and laboratories, all under jurisdiction of various branches of the government. These branches are the Academy of Sciences of the USSR, the Academies of Science of the various constituent republics, academies of a particular branch of science, industrial ministries, etc.

The USSR Academy of Sciences is responsible for about 100 research institutes, with a total staff of around 30,000 persons. Of these, 11,000 are research scientists and technologists. The Ministry of Power Stations controls the following research institutes: (1) Thermotechnical, Moscow; (2) Hydro-technical, Leningrad; (3) Hydro-technical, Tiblis; (4) D-C Research Institute, Leningrad, with a branch in Moscow; (5) Research Institute of the Peat Industry. The Ministry of the Electro-Technical Industry is responsible for the manufacture of all electrical equipment and also controls several research institutes, among which is the All-Union Electrical Engineering Institute, V. I. Lenin in Moscow. Other research institutions in the electrical engineering field are controlled by the Ministry of the Radio-Technical Industry, the Ministry of Heavy Industries, etc.

The USSR is engaged in the development of ehv power transmission (a-c and d-c) on a prodigious scale. They have evolved a plan for a single power grid for the European part of the USSR and Central Siberia. The single power grid will permit the integration of all electric power generation in the USSR for optimum economy and maximum power availability.

In 1956, the total energy generated was 192 billion

Revised text of a conference paper presented at the AIEE Winter General Meeting, New York, N. Y. Feb. 2-7, 1958. Recommended for publication by the Educational Publications Committee.

P. A. Abetti and G. F. Lincks are with the General Electric Company, Pittsfield, Mass.

The authors gratefully acknowledge the assistance of E. V. DeBlieux, L. W. Morton and S. Sass, of the General Electric Company.

КОММУНИЗМ—ЭТО ЕСТЬ СОВЕТСКАЯ ВЛАСТЬ
ПЛЮС ЭЛЕКТРИФИКАЦИЯ ВСЕЙ СТРАНЫ (Ленин) A

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ОСНОВАН
в 1880 г. B

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ОРГАН АКАДЕМИИ НАУК СССР, МИНИСТЕРСТВА ЭЛЕКТРОСТАНЦИЙ СССР
И МИНИСТЕРСТВА ЭЛЕКТРОТЕХНИЧЕСКОЙ ПРОМЫШЛЕННОСТИ СССР

Иркутская гидроэлектростанция

Инж. Б. З. УМАНСКИЙ, инж. Н. И. ФЕДОТОВ
и инж. И. М. ЧАЛИДЗЕ

Московское отделение Гидроэнергопроекта

В декабре 1956 г. вступила в пусковой период Иркутская гидроэлектростанция—первенец Ангарского каскада. Этим начато использование огромных потенциальных гидроэнергетических ресурсов р. Ангары, превосходящих суммарные запасы гидроэнергии таких четырех рек Европейской части Советского Союза, как Волга, Кама, Днепр и Дон.

Озеро Байкал принимает на себя воды более чем 300 рек, а дает начало только одной реке — обычны и не похожи на компоновку и состав сооружений, например, таких гидроузлов, как Горьковский, Щербаковский и Куйбышевский. Особенностью является отсутствие в составе его сооружений бетонной водосливной плотины. Напор создается право- и левобережной глухими земляными плотинами, а также зданием гидроэлектростанции, расположенным в створе с указанными плотинами в русловой части реки у левого берега.

Fig. 1. Frontispiece of the journal *Electricity* (*Elektrichestvo*) showing quotation from Lenin (A) and the year in which the journal was founded (B).

kwh (approximately 1/3 of United States generation) of which 85% was fuel and 15% hydro. At present, generation doubles every 5 years in the Soviet Union as compared to every 10 years in the United States.

The USSR has enormous water power resources which, because of the difficult construction problems, have not been developed as fast as fuel burning generation. Rapid progress has been made since World War II in harnessing the European rivers—Dnieper, Volga, Don, Dniester, and others. A start has been made on the Siberian rivers. By 1960, 18.5% of Soviet generation will be hydro. Some typical capacities of hydroelectric stations are: Stalingrad—2,300 megawatts (mw), Bratsk—3,600 mw, and Krasnoyarsk—4,000 mw. The 4 largest rivers in Siberia will have a capacity of 35 million kw, and produce 200 billion kw-hr per year. The generators at Bratsk will be rated at 200,000 kw each; and at Krasnoyarsk 285,000 kw each.

The USSR expects to place the first section of a large atomic power plant in service in 1960. This section, rated 420,000 kw, consists of 2 nuclear reactors feeding 60,000 to 70,000 kw steam turbines. After 1960, atomic power will have an increasingly important place in the Soviet Union's electric generation.

Proof of the conviction of USSR engineers that the regional grids must be linked into a single grid is found in the tremendous scale of their ehv transmission advanced development work. There are conflicting views in Soviet engineering circles regarding a-c versus d-c transmission, but they all agree that ehv transmission is a vital necessity for the future development of the Soviet economy. They also agree that the only way to find out is by extensive theoretical and laboratory research and by actually building and operating extensive ehv transmission systems. Thus, for instance, the Kuibishev–Moscow 540-mile 400-kv line was operated for a certain period at voltages near 500 kv, before the decision was reached to convert all of the 400-kv grid to 500 kv. Similarly, the 280-mile link between Stalingrad and the Donbass in this a-c grid will be built for 2 x 400 kv d-c. Soviet engineers recognize that this will cost several per cent higher than if it were built for a-c, but feel that the operating experience they will gain will be definitely worth this additional expense in view of the final decision to be made for the aforementioned single power grid, which most probably will require the highest transmission voltages in the world (up to 650 kv a-c and 2 x 500 kv d-c, or maybe even higher).

There are at least 20 institutions working on the planning, investigation, and development of the Soviet a-c and d-c ehv systems. Some of the most important ones, visited by one of the authors, will be described later. Research, development, design, and building of the first samples plus the training of engineers is done by research institutes. Also, some research is done in the educational institutes and universities. A possible organization of research activities on the ehv field is shown in Fig. 2.

With the new reorganization to decentralize industry, which is being put into operation, the aviation, radio-engineering, defense, shipbuilding, chemical, power stations, and medium machine-building industries will continue to be administered by the Ministry at Moscow.[2] These major industries require a high degree of technical research and development which would be impractical to duplicate several times in different plants.

A few years ago, electrical engineering research in the USSR[3] was frequently subjected to Communist Party edicts and pressure purges in some of the leading institutes. Apparently since Stalin's death, the accent is more on the quantity and quality of the technical results than on politics. During the IEC meeting, Soviet electrical engineers generally were very friendly, co-operative, and eager to interchange technical knowledge.

TECHNICAL JOURNALS

SOVIET AND FOREIGN electrical engineering activities, new developments, results of original research, reports of practical operating experiences, are very well covered in several journals published in the Soviet Union. All these are published by the State Power Publishing House (Gosenergozdat) of Moscow.

The most important USSR electrical engineering journal and the best known in this country is *Electricity (Elektrichestvo)*, which was founded in 1880. This journal is an official publication of the USSR Academy of Sciences and of the Ministry of Power Stations. It publishes every month leading articles concerning scientific investigations, electrical engineering developments, and new system developments and plans; for instance, descriptions of the Soviet 400-kv a-c system and the Stalingrad–Donbass proposed 800-kv (±400 kv) d-c system, etc. The subject matter and quality of its contents are very similar to those of the AIEE *Transactions* or of the *Proceedings* of the Institution of Electrical Engineers (British). *Elektrichestvo* also has special sections entitled "From Operating Experience," "From the History of Electrical Engineering," letters to the editor and discussions, a chronicle of electrical engineering meetings, summary of articles appearing in other engineering journals (mostly foreign) and a bibliography (mostly USSR). Generally speaking, the quality of its contents is quite good, with a tendency toward academic contributions. There are practically no advertisements in its 96 pages per number and no commercial articles. The other electrical engineering journals published by Gosenergozdat are:

1. *Electric Stations*—12 issues per year.
2. *Power Economy Beyond the Frontiers*—6 issues per year.
3. *Hydro-Technical Construction*—12 issues per year.
4. *Thermal Engineering*—official publication of the USSR Ministry of Power Stations and of the USSR Academy of Science—12 issues per year.
5. *Peat Industry*—8 issues per year.
6. *Industrial Power Engineering*—12 issues per year.
7. *Illumination Engineering*—official publication of the USSR radio industry—12 issues per year.
8. *News of the Electrical Industry*—12 issues per year.
9. *Power Engineering*—the manufacturing technical journal for the masses—12 issues per year.
10. *Electrical Engineering Abstracts Magazine*—issued by the Institute of Scientific Information of the USSR Academy of Sciences.

The journals listed as 2, 4, 5, 6, 7, and 9 are all official publications of the Ministry of Power Stations of the USSR. It is particularly interesting to note that there are two journals devoted, one in total and the other in a large part, to the translation and abstracting of foreign publications. The Soviets study all foreign data very carefully, much more than we do theirs. All research institutes have a group of translators who devote their entire time to translating articles from the foreign press. They appear to be more interested in practical solutions than in experimental procedures.

TECHNICAL CONFERENCES

SOVIET ELECTRICAL ENGINEERS meet frequently in technical conferences, some of which are reported in *Elektrichestvo*. These conferences are somewhat different from our AIEE meetings, which usually cover a great variety of subjects in different sessions taking place simultaneously. Instead, the USSR conferences, from the available information, appear to be devoted to special subjects of particular importance or timeliness.

A typical example is the conference devoted exclusively to long-distance power transmission, which was held at the Kalinin Polytechnical Institute in Leningrad in May 1956 and was attended by more than 300 persons from research and design institutes, factories, plants, and power societies. Of these, 60 belonged to organizations located in Leningrad, the others came from all parts of the USSR. Sixty-four technical papers were presented and discussed. The opening paper was by M. P. Kostenko, of the Leningrad Politechnical Institute and the Academy of Sciences, on "The Tasks of the Design, Industrial and Research Organizations in the Field of Long-Distance Electrical Transmission." He declared that Soviet industry must be able to build (1) hydroelectric generators and turbogenerators rated 300 megavolt-amperes (mva) in a single unit, (2) transformers and autotransformers rated 300 mva, 600-650 kv, (3) circuit breakers rated to interrupt 20,000 to 25,000

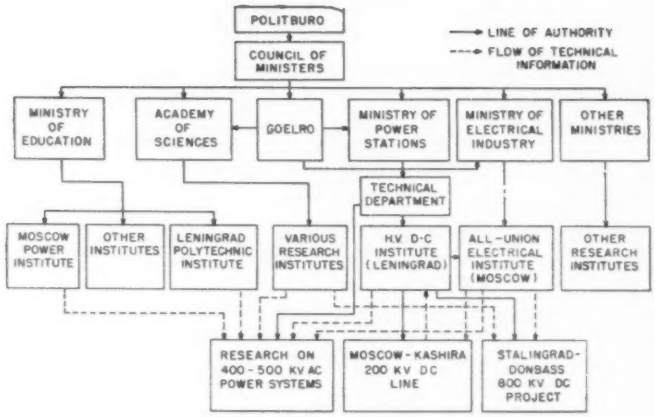

Fig. 2. Possible organization of research activities in the extrahigh-voltage field.

Glossary of Names in Fig. 2

Politboro. **Political Bureau of Communist Party—Controls party legislative and administrative branches of government.**

Ministry of Education. **In charge of all elementary secondary and higher education in USSR.**

Academy of Sciences. **In charge of scientific research and development.**

Goelro. **State Commission for Electrification of Russia (planning board).**

Ministry of (Electrical) Power Stations. **In charge of all electrical power stations and systems.**

Ministry of Electrical Industry. **In charge of electrical power equipment manufacturing industry.**

Moscow Power Institute. **Engineering college.**

Other Institutes: **Engineering colleges.**

Lenin Polytechnical Institute. **Engineering college.**

Various Research Institutes. **Those involved in electrical research projects.**

High Voltage D-C Research Institute. **Research and development of high-voltage a-c and d-c systems.**

All-Union Electrical Institute (Moscow). **Development and design of high-voltage apparatus.**

Other Research Institutes. **Those involved in development and design of apparatus.**

400- to 500-Kv A-C Power Systems. **550 to 650 mile, 1.5 million kw commercial lines in operation and being built.**

Moscow–Kashira 200-Kv D-C Line. **180 mile, 30,000 kw experimental-commercial line.**

Stalingrad–Donbass 800-Kv D-C Project. **800 mile, 750,000 kw line being developed and constructed for commercial use.**

mva at 600-650 kv, (4) all other apparatus required for terminal stations and transmission lines at 600-650 kv. The speaker also discussed the use of electrodynamic models to study the problems of operation of long-distance transmission systems.

RESEARCH INSTITUTES

THE ALL-UNION ELECTRICAL ENGINEERING INSTITUTE (Moscow)[4] was founded in 1921 by direct order of Lenin, and is the forerunner of all research institutes in the USSR. Most of the 15 branch institutes that grew from the original Moscow Institute are now independent.

The function of training engineers was discussed in Part I of this article.[1] The Institute has awarded over 100 advanced degrees in the past 20 years and currently has 40 engineers doing postgraduate work.

Research activities of the Moscow Institute include: (1) high voltage power equipment, including switchgear and arresters, (2) high voltage power rectifier equipment (400 to 800 kv), (3) pumpless mercury arc rectifiers, (4) trolley and subway drives and controllers, (5) semiconductors, (6) insulation materials of all kinds, and (7) industrial electronics.

Advance design for production of power equipment up to 500 kv is another activity of the Moscow Institute. As in other research institutes, this work involves the development and design of electrical equipment, the preparation of drawings and specifications and the building of 10 or 12 samples. Following this, the drawings and specifications are turned over to the manufacturing plant or plants, as designated by the responsible ministry, and the device is produced. In answering the question of one of the authors, the manager of the All-Union Institute said they learned during World War II that it is necessary to have engineers representing the Institute in the manufacturing plants to check on the product, to interpret drawings, and to help overcome difficulties.

The Institute has approximately 600 engineers, 1,000 clerical people, and 600 manufacturing people, making a total of 2,200. It has good test facilities and is expanding very rapidly. Its size, within the next 3 to 5 years, will be doubled.

A new high-voltage laboratory is in the process of being built which will include: (1) An impulse voltage generator, 22 meters (72.5 feet) high, providing 7,200 volts with a capacity of 400 kw per second; (2) Three transformers in cascade to provide 2.25 million volts at normal power frequency of 50 cycles; and (3) A 30-foot square, 19-foot deep tank, and a 13.5 foot round tank (oil filled or evacuated) for general test purposes and for tests under controlled pressure and temperature conditions. Glass windows in the side permit observing the test equipment. A comparison between these facilities and those presently available in the Pittsfield Laboratory of the General Electric Company, among the largest in the world, is shown in Fig. 3.

On the other hand, the present high current interrupting test for switchgear, etc., has only a 1,000 microfarad bank of capacitors and is capable of giving 50,000 amperes at 50 kv. Other countries use 50-60 cps motor generator sets. Soviet engineers recognize the limitations of such equipment and hope to have adequate facilities later.

The Direct-Current Research Institute[5] (Leningrad) was organized in 1947 to investigate and develop long-distance ehv d-c transmission and soon after long-distance power transmission for 3-phase a-c, at 400 kv and higher voltages, as well as the problems relating to interconnection of power systems, both a-c and d-c.

The Institute at present employs about 600 people in Leningrad: 250 scientists and engineers, 200 workmen, and 150 administrative and clerical personnel. Its budget is about 10 million rubles. The Institute com-

prises six laboratories, a small construction department, and the Moscow Branch, as follows:

1. The Laboratory of Electrical Regimes investigates d-c power transmission.
2. The Valve-Laboratory investigates and devises high voltage ion-valves.
3. The Control and Protection Laboratory studies problems of grid-control, regulation and protection for d-c power transmission.
4. The High-Voltage Engineering Laboratory investigates the problems of line and station insulation and corona effects on a-c and d-c transmission lines, studies internal overvoltages of long a-c transmission, develops measures for limiting internal overvoltages, determines rational insulation levels, and studies the performance of capacitors under different service conditions.
5. The Electric Systems Laboratory investigates system operation problems of long a-c transmission lines and parallel operation of interconnected power-systems.
6. The Measurements Laboratory is engaged with problems concerning measurements of converter schemes, develops methods and testing apparatus for insulation fault location on long cables and overhead lines.
7. The Construction Department designs specimens of certain equipment and apparatus as well as experimental installations.
8. The Moscow Branch of the Institute is comprised of a test commercial d-c transmission line Kashira–Moscow for 200 kv, 30,000 kw. This line is 112 kilometers long (approximately 70 miles). The branch has two laboratories and staff of 70 engineers for its investigations.

The Institute uses real transmission lines and power systems equipment for its experimental studies. In investigations of the operating conditions of interconnected power-systems and the internal overvoltages of a-c transmission systems, use had been made of generators in hydroelectric plants, of 220-kv lines with series-capacitors, as well as the 400-kv Kuibishev-Moscow transmission line. The 200 kv d-c Kashira–Moscow transmission line serves as experimental basis for d-c power transmission problems studied under real conditions.

Among the significant test facilities of the D-C Research Institute are the high voltage laboratory, with an impulse generator rated 4.3 million volts and 165 kw per second and a d-c impulse generator rated 1.2 million volts with 70 ma (200 milliamperes for 10 seconds), and a high impulse current generator rated 500 kiloamperes at 200 kv. Particularly interesting is the micro-network of physical models which can duplicate the transient performance of any a-c or d-c system. It comprises miniature steam, turbo, and hydro generators with replaceable rotors to represent different types of machines and miniature generator and turbine regulators, transformers, series capacitors, equivalent line resistances and reactances, etc. All characteristics are similar to the actual equipment. The systems are loaded by motor generator sets. The control panels permit duplicating in miniature the a-c transmission system. One section in the control panels has miniature rectifiers so one or more overhead or underground d-c transmission lines can be added to the a-c network. This equipment is used to solve complicated problems of interconnection involving stability, control or regulating devices, and transient and steady-state conditions on the line. At present, the Institute is studying the possibility of supplementing the physical modeling by use of network-analyzers for the solving of complicated problems of interconnected power-systems parallel operation. A complete simulation of d-c transmission system is available in another laboratory for studying problems of d-c transmission.

EQUIPMENT	MOSCOW ALL UNION INSTITUTE LABORATORY	GENERAL ELECTRIC PITTSFIELD LABORATORY
SIZE	96′ x 187′ x 115′ HIGH	95′ x 170′ x 85′ HIGH
POWER FREQUENCY VOLTS	2,250,000	1,750,000
IMPULSE GENERATOR VOLTS CAPACITY	7,200,000 400 KW SECONDS	(2) EACH 5,100,000 85 KW SECONDS

Fig. 3. Comparison between the high-voltage laboratory facilities of the Moscow All-Union Institute and the General Electric Company's Pittsfield, Mass., facilities.

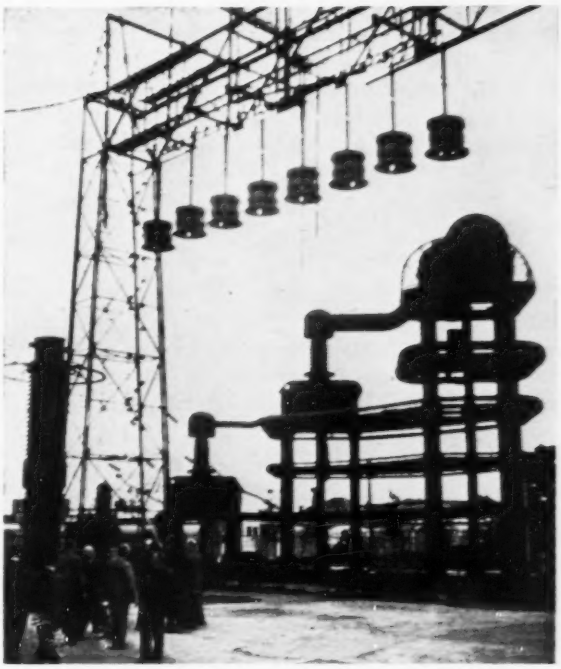

Fig. 4. The 750 kv, 750 kva transformers for charging the experimental a-c line at the D-C Research Institute in Leningrad.

The Institute operates the highest voltage experimental a-c line in the world (Fig. 4). It is about 0.6 miles long and built for 650 kv, but operated only up

to 600 kv. It is energized by 3 transformers rated 750 kv, 750 kva each. The line conductors can be changed to study different configurations and spacings. At the time of the visit, bundle conductors were studied with 3 and 4 subconductors per phase, as in the Soviet 400 kv a-c system now in operation, and for the proposed a-c lines for 500 kv a-c and 600 kv a-c.

CONCLUSIONS

1. The USSR is instilling an understanding and respect for the scientific approach in all of its people by early teaching of science, using a high percentage of class room time, regardless of whether the student will eventually dig ditches or become an engineer.

2. The USSR concentrates very heavily on the training and use of engineers in developing and carrying out the present and future planned growth of their country.

3. Electrification of all the USSR has had a very high priority since 1920, and has produced real results in educational progress, research facilities, and in the creation of equipment and operating systems that meet USSR requirements.

4. Education in engineering in the Soviet Union provides a basic foundation in the first two or three years and then peaks to a high degree of specialization especially in the 5th year, which is somewhat comparable to the on-the-job specialization which young American engineers get in industry after graduation.

5. Soviet educational institutes and universities, reported to be graduating 71,000 engineers, use their facilities for approximately the same number of hours per day and months per year as in the United States. The ratio of students to teachers is also similar to that in the United States. Thus, it appears the USSR has physical facilities and teachers far in excess of those available in the United States, which are presently heavily taxed to graduate 25,000 to 30,000 engineers per year.

6. Capable students are aided in securing a higher education in engineering or other subjects by free or low tuition and by being paid a monthly stipend. They are encouraged to study by an extra stipend for high grades and by the advanced position and higher pay attainable after graduation through advanced education.

7. Research facilities in the USSR in research and educational institutes are excellent. Many of their extensive facilities for the simulation of a-c and d-c extrahigh-voltage systems, for instance their unusual miniature physical models, are possible only where there is standardization such as imposed by their one management and where capital expenditures are government financed and do not have to be liquidated by the product or users benefited.

8. Krushchev's decentralization plan recognizes the availability of sufficient engineering personnel to manage development and production activities in decentralized regions and areas, whereas previously a shortage of engineers necessitated centralization in Moscow and Leningrad.

9. Indoctrination in communist ideology starts with the entrance of the boy or girl in the elementary school and continues through the whole educational period. Knowledge of and loyalty to this ideology is a requisite for entrance into the higher positions of responsibility in the USSR.

10. The people of the United States and the world should recognize that in the future this high standard of education and research, coupled with the ability to get extreme concentration in any desired area, will give the USSR technological firsts in more areas than the artificial satellites, Sputnik I and II.

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Missile Testing Inductance Coil

A huge inductance coil designed and built at Westinghouse Electric Corporation's transformer division, Sharon, Pa., is now being used to supply energy to an electric-arc tunnel for testing missiles.

The coil is similar to that used on a current-limiting reactor, except for the vast difference in size. Whereas a normal current-limiting reactor is wound with two or three 500-mcm cables, this coil is wound with thirty-six 850-mcm cables in parallel. The huge coil measures 119 inches in diameter, as compared to approximately 35 inches for a current-limiting reactor.

Energy is stored in the coil when its field is built up by a d-c source; the arc chamber circuit is closed at this time. Contacts in series with the coil are then opened. An arc is produced in the chamber by the instantaneous collapse of the strong magnetic field in the coil. This heats the air in the arc chamber to 40,000 F and raises the pressure to 30,000 psi. The plastic seal vaporizes, releasing a blast of hot gas which rushes through the test section and into the vacuum chamber at the incredible speed of 32,400 mph.

The coil, the largest ever built, is part of Tunnel Hotshot II in the Gas Dynamics Facility at the Arnold Engineering Development Center near Tullahoma, Tennessee. Hotshot II will permit advanced research into many areas of aerodynamics and astronautics heretofore restricted in scope such as the problem of reentry into the atmosphere of a missile's earthward plunge from space.

New Printing Demand Meter

P. V. TERRY

THE NEW PRINTING DEMAND METER illustrated in Fig. 1 was designed to provide the needed long life meter which could more accurately measure and permanently record electrical demand information. Accuracy compatible to that of the watt-hour meter, which acts as the primary sensing device and impulse generator for the printing demand meter, is a design feature of the new printing demand meter.

The new design eliminates carbon tape, spools, guides, and associated driving mechanism which have been necessary in the past. The elimination of these parts is made possible by having a single record tape especially coated to provide a surface which can be permanently marked by pressure against the coating. A layer of white paper is coated with black or other suitable dark color. This then is coated with a spongy whitish layer. Where the spongy layer is compressed or physically removed, the dark coating will show. The action of the platen on the paper when it strikes the counter figures causes the dark undercoating to show, duplicating on the record paper the figures of the counter at the instant of impact.

Fig. 2 is the accumulator assembly. It consists of a shaft, an impulse motor driven gear secured to the shaft, and a second gear loose on the shaft but held in position relative to the first gear by means of a helical spring. A pin on each of the gears extends to overlap the other and prevent more than one revolution of relative motion between the two gears.

The two pins are biased together by the spring. The second gear rotates with the motor driven gear and drives the printing counter except when the counter drive gear is locked during reset. In this condition, the motor driven gear will rotate with each incoming impulse and cause the spring to wind up. At the completion of reset, the locking cam moves out of the way of the pin on the counter drive gear. If any impulses have been received during the reset period, the accumulator spring will unwind rotating the counter drive gear until the stop pins on the two accumulator gears meet.

Any impulses received during reset are in this way registered on the printing counter.

It was found that the action on the spring unwinding was too fast to get proper life or registration of the impulses on the printing counter. A way to slow this action was needed.

The method finally evolved consists of a ratchet wheel fastened to one of the accumulator gears and a rocking arm escapement mounted on the second accumulator gear. The inertial forces resulting as the weighted rocking arm escapement is caused to oscillate by the ratchet wheel keeps the speed of the spring driven gear within bounds.

The new printing demand meter described in this article has been designed to measure demand more accurately than its predecessors, to be smaller in size, and to cost less. In particular, the application of the described means of accomplishing the desired actions in a printing demand meter have, in the opinion of the author, advanced the art of demand metering.

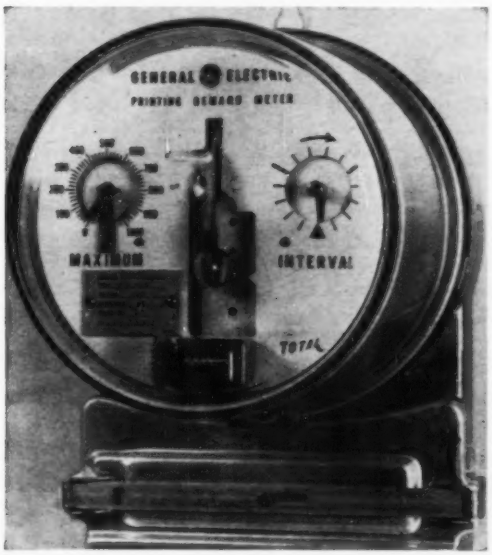

Fig. 1. New printing demand meter.

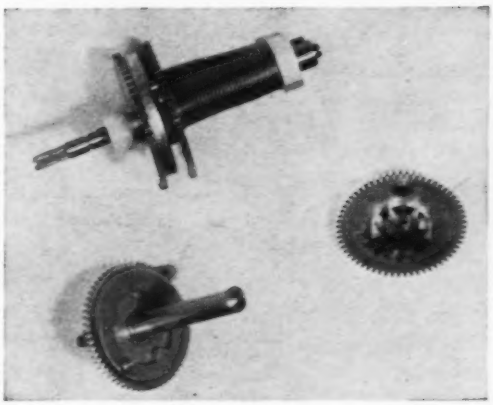

Fig. 2. Accumulator and governor.

Digest of paper 58-146, recommended by the AIEE Indicating and Integrating Instruments Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Feb 2-7, 1958. Scheduled for publication in AIEE *Communication and Electronics*, 1958.

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A General Purpose Selective Signaling and Control System

W. V. K. LARGE

H. J. MICHAEL

A description is presented of a selective control system that is economically attractive and flexible enough to permit centralized, fail-safe control and supervision of certain facilities of right-of-way companies.

THERE HAS BEEN a continuing and growing desire upon the part of Bell System customers for an economical selective control system for multistation private line service. Interest has been indicated by the increasing number of inquiries received from companies in the railroad, pipeline, and power distribution fields. These needs, in the past, have been satisfied in various ways by the telephone companies. In some cases, lines have been leased to the commercial companies, who in turn have applied their own signaling and terminal apparatus. In other cases, lines have been leased and the signaling apparatus individually engineered by the telephone company. It has become apparent that there would be advantages, economic as well as technical, both to the customer and to the Bell System, in furnishing for these services an integrated system including lines and selective signaling equipment. To meet these needs the *SC2* selective control system has been developed and is now available as a standard Bell System offering.

The general purpose of a selective control system is to permit an operator or dispatcher at a main or control station to perform various functions at outlying stations by remote control. These functions include the two-way operation of power switches, circuit breakers, motors and valves, and the connection to telemetering devices which would otherwise require dispatching a man to the remote location. In addition, the system must be capable of continuously supervising the status of control and alarm devices and maintaining a current record of these indications at the main station.

To satisfy the need for this type of operation, a selective control system must meet certain requirements unique to this type of service. These include the capability of operation on a multipoint line with extreme "fail-safe" reliability, interconnection with special customer control devices, and the ability to transmit telemetering information. It is desirable that the system be compatible with, and able to transmit its signals over, any Bell System circuit, including narrow-band telegraph channels. In addition, the equipment must be arranged for ease of maintenance on customer premises.

After an extensive study of the requirements of potential customers and the evaluation of a trial of an experimental system, the *SC2* selective control system has been developed to provide a standard Bell System offering in the field of selective control and supervision. It is expected that this system will meet the technical requirements of a high percentage of prospective customers, will be economically attractive, and will be flexible enough to permit its use for a large number of services.

CHARACTERISTICS AND FEATURES

THE *SC2* SYSTEM, as previously mentioned, provides means to permit centralized, fail-safe control and supervision of certain facilities of right-of-way companies. The system comprises a main station, where all the major complexity of control is centralized, and one or more relatively simple control or satellite stations connecting to the customers equipment. A summary is presented of the principal characteristics and features of this system:

1. At the main station, selective, decimal, time division order codes are used to address and initiate the control of a plurality of two-state devices located at remote points. Two-state functions, such as operating and tripping power switches, opening and closing valves, etc., are permitted.
2. Inquiry codes using the same type of signals can be sent to determine or check the status of any two-state device.
3. Simple signals are automatically returned from the satellite station after either an order or an inquiry to indicate the status of remote devices to the main station.
4. A roll call which, periodically or when desired, makes inquiries of all two-state devices provides a complete check of the status of the network and of all devices in the system. In cases where a remote device operates or releases for reasons other than an order, a roll call is automatically started to find the device and to alert the main station attendant.
5. The main station exhibits a continuous display of the status of all remotely controlled two-state devices. Flashing lamps and audible alarms are used to alert the attendant when necessary. All keys and lamps at the main station are mounted in a console type control position.

A special article recommended for publication by the AIEE Data Communication Committee.

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6. The structure of the codes sent from the main station and the checks which the system makes upon these codes provides a high degree of system reliability. At the main station, all codes are generated by push-button operation.

7. The system is designed to operate over various types of narrow-band channels. Only one channel is required for a system.

8. The system is exceedingly versatile and flexible. It is arranged to provide any or all of a wide variety of optional features which should meet any foreseeable customer requirements.

9. Maintenance is integrated with the network maintenance functions of the central office telephone or telegraph testboards.

10. Plug-in units provide for rapid and easy maintenance. This also facilitates additions or changes in the system.

11. Junction with the customers equipment is made at a low-voltage point.

In addition to these basic features, the system is arranged for a number of optional features, such as connecting customer-owned telemeter transmitters and receivers to the line, selective signaling of satellites for alerting purposes, and continuous or step control of remote devices. A monitor station is also available which will display at remote points continuous indications of the status of all devices similar to those appearing on the display panel at the main station.

GENERAL PHILOSOPHY

THERE ARE TWO BROAD AVENUES of approach in the design of any system where the reliability requirements are such that all orders transmitted must be acknowledged and the status of all associated devices continuously supervised:

1. The satellite could be arranged to encode and transmit the acknowledgment and alarm signals. In this case, the necessary encoding and sending equipment must be provided in every satellite and receiving and decoding equipment must be furnished at the main station. Also, on multipoint circuits, positive means must be provided to ensure that there be no interference should two or more satellites attempt to transmit alarm indications simultaneously.

2. The satellites may be interrogated periodically or as required by the main station. In this case, the satellite stations can be made relatively simple. They may be arranged to transmit only a "yes" (long pulse) or a "no" (short pulse) indication as status or acknowledgment signals. Similarly for an unordered change, only simple pulses are transmitted to initiate alarms. This necessitates the use of sequential addressing at the main station —the roll call technique—to ascertain the location and the nature of the changed condition.

The procedure in foregoing step 2 was followed in the design of the *SC2* system for several reasons. Inasmuch as the *SC2* system was being developed for use on multipoint as well as point-to-point systems, interference between satellites can be more easily and economically prevented with this arrangement. Also, with this arrangement, the simplicity of signals from the satellite allows relatively inexpensive satellite sending equipment and main station receiving equipment with a negligible sacrifice in reliability.

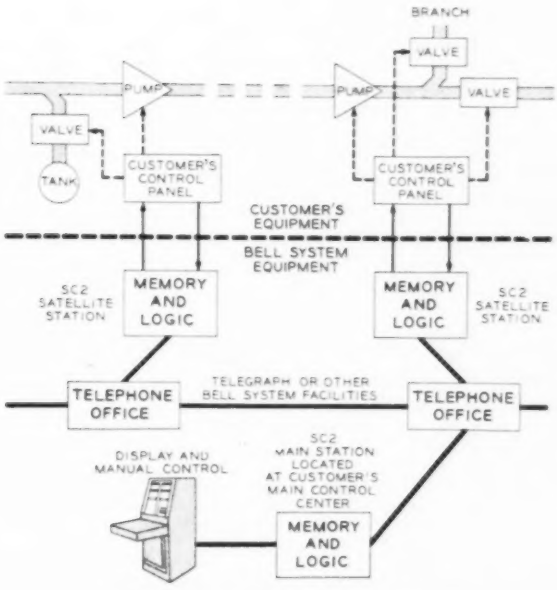


Fig. 1. Application of the SC2 system to a pipeline.

RELIABILITY

AN IMPORTANT FACTOR contributing to the fail-safe reliability of the system is the time division order code. Each digit of the codes transmitted from main station to satellite stations consists of 2 long and 3 short pulses. Self-checking "2 out of 5" codes have been used very widely throughout the Bell System heretofore on a frequency division basis. The *SC2* system adapts the principle to time division codes. Because every digit consists of the same number of long and short pulses, properly separated, the code can be made error detecting. Anything other than the proper combination of pulses, represents a mutilated code and is rejected by the receiving device at the satellite station. An additional parity checking feature assures that the correct total number of pulses is received.

Other factors contributing to the reliability of the system include the required acknowledgment of all code transmissions. Audible and visible alarms are provided when acknowledgments are not received. In addition, all equipment is of proved reliability and is manufactured to the same quality standards as that for all other Bell System services.

SYSTEM PLAN AND APPLICATION

THE MANNER in which the *SC2* systems may be applied to a pipeline is indicated in Fig. 1. Above the solid

Fig. 2. Main station control console.

line is seen the satellite stations along the pipeline with the customer's associated pump, pressure, and other controls. Below the line are seen the Bell System provided *SC2* main and satellite station equipments which are used to initiate control of, and otherwise exchange information with, the customer's control devices.

In addition to the necessary selective signaling transmitting and receiving circuitry, both the main and satellite stations are equipped with logic and memory circuits. These function to initiate control of, and to supervise continuously, the status of all associated customer devices.

Two arrangements are provided for passing control signals between the *SC2* system and the customer control equipment. The first provides short closures on two pairs of leads to the customer device. A momentary closure on one pair calls for the active condition of the device and a momentary closure on the other pair calls for the inactive condition. The second consists of a relay per controlled device which is held operated (from the *SC2* system) for one condition of the customer device and released for the other condition.

DETAILED OPERATION

Control Console. The control console at the main station (Fig. 2), is at present arranged for a maximum of 80 control functions, 60 of which may be for two-state devices. This does not represent the maximum capability of the system however, as the present circuit design will provide for the use of 1,000 three-digit codes. Control equipment may be employed up to the code capacity of the system. The console equipment for each two-state device consists of three or four lamps and three nonlocking push-button keys on the face of the console (Fig. 3). A red lamp shows the active condition of the remote device: a switch is closed, a motor is running, or a valve is open. A green lamp shows the inactive condition: an open switch, an idle motor, or a closed valve. One of two keys, when operated, sends out a coded signal to place the remote unit in the active condition, the other key performs the reverse function by changing the condition of a remote unit from active to inactive. In either case, the receipt of a coded signal at a remote equipment location closes contacts to effect the desired change. Other contacts on the customer's equipment close when the desired operation is complete to send an acknowledgment signal back to the main station. Here the receipt of this signal changes the indicating lamps to show the new condition.

A third key, when operated, sends out an inquiry code requesting the status of the associated equipment unit. The answer either confirms the condition shown by the lighted lamp or changes the lamps to indicate an unordered change. The detection of these changes, however, is placed on a more positive basis than the foregoing and this operation will be discussed in subsequent paragraphs.

The third lamp, amber in color, is lighted if no answer is received in the 12-second interval following the transmission of an order or inquiry signal.

A fourth lamp associated with a two-state remote device is used when that device is of a delayed operating type. The operation of a line switch or other fast operating unit does not actuate this lamp. However, the remote starting of a motor or generator, or the opening or closing of a valve, may take several minutes. In all cases, an answer to an order is returned from the satellite within about 6 seconds. In the case of delayed operation, this answer from the station to the order received will merely indicate that the order has been received since several minutes may be required before a change of state occurs. At the main station, this answer

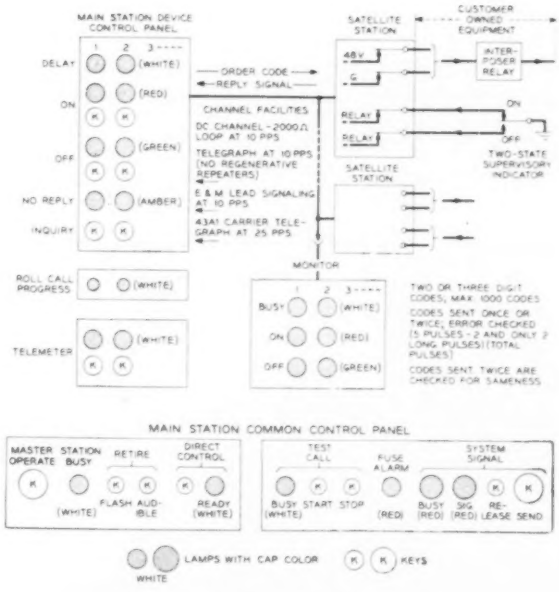


Fig. 3. Block diagram of control console.

will light the white lamp in the designation strip as an indication that the order has been received at the satellite, but completion will be delayed. When the operation of the customer device at the satellite is completed, a closure of contacts on the customer unit will initiate an exchange of signals between satellite and main station which will result in retirement of both the former status lamp condition and the white delayed completion lamp, accompanied by the lighting of the status lamp which shows the new condition of the equipment.

In addition to the keys and lamps associated with the remote equipment, a group of common control keys and lamps are located at the bottom of the console face. They include a master operate key which must be operated simultaneously with any order key. A station busy lamp is lighted during the time a code is sent out and an answer is received. Any change which takes place in a remote equipment unit and is not the result of an order produces a corresponding change in the lamp display in the control panel. In this case, the lamp flashes at a constant rate and an audible alarm is actuated. Keys in the common control bank permit the operator to change the flashing lamp to steady and to silence the audible alarm each independently of the other. The remaining keys and lamps in the common control group are involved in the manual start and stop of a roll call, direct and system controls, which will be described later, and fuse alarm.

Satellite Signals. As previously mentioned, only two signals are passed from the satellite to the main station, a short pulse of 100 milliseconds or a long pulse of 400 milliseconds. The first indicates an inactive condition, the second an active condition. Any change, not the result of an order, which takes place in the condition of a remote equipment unit, results in the transmission of an uninvited pulse to the main station to initiate a roll call.

Roll Call. In the roll call, an inquiry code is sent out to the first remote equipment unit just as though the inquiry key for that unit had been operated. The answer from the station confirms the lamp display or makes the required change. An inquiry is then sent out to the second unit in the roll call. This operation proceeds until answers (or no replies) have been received from all units in all stations. A roll call may be initiated in any one of four ways:

1. By reception of an uninvited pulse from any satellite station.
2. By closure of a contact on the program clock where roll calls may be set up on any interval basis from 15 minutes to 24 hours.
3. Manual operation of a roll call start key in the common key equipment on the console.
4. From the monitor console, if provided in the system.

In installations where several devices are controlled from each of several satellite stations or where a large number of devices are controlled from one satellite, the roll call, initiated by the reception of an uninvited pulse, is arranged for grouping. That is, the first inquiry will determine whether a change has taken place in a particular group of devices. If no change has occurred in that group, it will be passed by and an inquiry will be directed to the next group. Only those groups will be polled individually where a change is indicated by a positive answer to the group inquiry. This group roll call arrangement permits rapid determination of the source of the uninvited pulse.

Assuming a roll call of 50 devices, divided into 5 groups of 10, the average time required to locate an alarm condition is 14 or 20 seconds with pulsing speeds of 25 pulses per second (pps) and 10 pps respectively.

Should a control operator desire to initiate an order while a roll call is in progress means are provided so that he can manually stop the roll call. After he has sent his order, he can manually restart the roll call.

If an alarm condition should arise in a satellite while a roll call is in progress, it may occur before or after its position is reached in the roll call. If before, the condition will be indicated by the roll call in progress. If its position has already been passed, the alarm signal will be stored in the satellite until the roll call is over and then transmitted to the main station. This will initiate another roll call. The only manner in which a stored alarm indication may be retired is by an inquiry signal from the main station.

Telemetering. The *SC2* system is designed to provide for telemetering in two ways, one over the regular *SC2* signaling channel and the other over an auxiliary telemetering channel.

1. Telemetering of the timed interval type is provided for operation over the regular *SC2* signaling channel. In this operation, a code sent out by the operation of a key in the console results in a connection to a given customer's telemeter generator at a remote station. This same key operation connects the customer's telemetering receiver at the main station. Signals from the telemeter generator over the signaling channel within a 10-second interval produce the desired deflection on the receiver unit.

2. A second type of operation is provided for continuous telemetering where a separate circuit is provided for this service. In this, the operation of a console key sends out a code to connect a customer's remote telemeter generator to the telemeter circuit. At the control end, the customer's particular telemeter receiver is connected to the telemeter circuit by the same key operation. Telemetering will be continuous until a second key is operated to obtain a reading from another remote generator. The coded signals sent out by this second key disconnect the first telemeter generator from the circuit and make connection to another generator at the same or another remote station. At the same time, a new connection is established in the main station to the same or another telemeter receiver as predetermined.

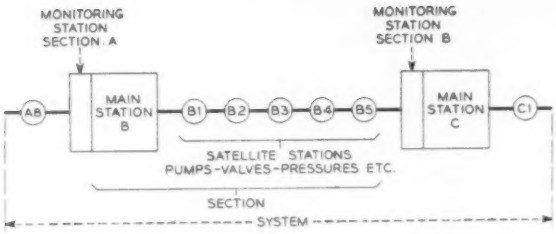


Fig. 4. Block diagram of monitoring circuit.

Direct Control. The *SC2* system provides direct control arrangements for raising or lowering voltages, partially opening or closing valves and so forth. A code, sent out to a satellite station, sets up a direct connection between the signaling line circuit and a driving motor or a stepping device for a rheostat or valve. The answer from the satellite to the main station lights a proceed signal lamp to inform the attendant that he has direct control. If the remote unit is motor driven, the attendant operates the control key adjacent to the proceed lamp. As a result, the distant motor runs as long as the key is held operated without a time limitation or until local limit switches are reached. When the desired setting has been achieved and the control key is released, both ends of the *SC2* system restore to normal. If the remote unit is of a stepping type, the attendant operates the key once for each step. There is a limit of about 10 seconds on this step-control operation after which the proceed lamp is retired. This cycle may be repeated immediately if required.

Group Codes. In the normal operation of the *SC2* system, each satellite two-state device has assigned to it a particular set of close and trip codes and it will operate only when the correct code is received on the line from the main station. There is also available, an optional arrangement whereby a single group code will initiate the simultaneous operation of any number of these same devices at any or all satellite stations. Such an operation may be used to stop or start all pumps at once along a given section of a pipeline or other similar services.

System Operation. The arrangement described under the preceding heading of group codes may be required, if it is desirable, for example, for operational or emergency reasons that all pumps in a pipeline operation be quickly shut down. This system signal can be initiated by the main station attendant, or by the operation of a key in any satellite station.

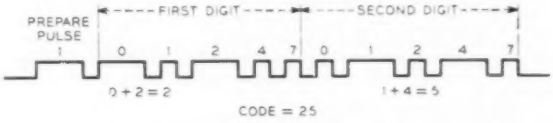
The system signal function can be applied in a system consisting of a single section (a single main station and its associated satellite stations) or a system comprised of a number of sections in series. In the latter case, a monitor circuit serves to link the sections together for the purpose of propagating the system signal to all sections (Fig. 4).

Monitoring. The display on the main station console indicates the current status of all devices associated with a section. Monitoring arrangements are available which permit a duplicate of this display to be provided at any location desired by the customer. Only one signaling channel is required to be directly connected to the *SC2* signaling channel for this purpose. In the monitor station as in the main station, no change in status is indicated until the answer from the customer device assures that the change has taken place.

The equipment required to receive and decode the signals for the monitoring display is basically similar to that provided in the satellite stations. The monitoring station also plays an important part in the systems signal operation outlined in a multisection installation.

SIGNALING

Codes. As stated earlier, the order information sent from a main station to a satellite station is in the form of a pulse length code (Fig. 5). Each digit consists of



PULSE POSITIONS ARE NUMBERED 0, 1, 2, 4, & 7. ADDITION OF NUMERALS ASSOCIATED WITH LONG PULSES GIVES VALUE OF DIGIT WITH ONE EXCEPTION, 4 + 7 IS TAKEN AS 0

Fig. 5. Two-digit code.

three short and two long pulses, the relative position of the long pulses in the sequence determining the numerical value of the code. A two-digit code is shown in Fig. 5. Note that the complete two-digit signal consists of a start or preparatory pulse followed by four long and six short pulses. In the five pulses following the preparatory pulse, the long ones are in positions

Table 1.

Digit	Positions of Long Pulses				
	0	1	2	4	7
1	x	x			
2	x		x		
3		x	x		
4	x			x	
5		x		x	
6			x	x	
7	x				x
8		x			x
9			x		x
0				x	x

0 and 2 indicating digit 2. In the second five, the long ones are in positions 1 and 4 for digit 5. Three-digit codes consisting of six long and nine short pulses are used where the number of operations requires more than 100 codes. Table I shows the positions of the long pulses for each digit.

At the satellite, the receipt of a prepare pulse conditions the station for the code which follows. The receiving circuit not only decodes the signal, but also checks that there are two and only two long pulses in

each group of five and that the total number of pulses is correct. Any variation results in no operation at the satellite station and a no reply indication at the main station.

The pulsing speed, determined for each installation, may be either 10 or 25 pulses per second. Short pulses are either 50 or 20 milliseconds in length depending upon the pulsing speed and long pulses are 150 or 60 milliseconds. The time required to send a two-digit code is 0.7 second or 1.7 seconds for 25 pps and 10 pps respectively.

Where desired, provision is made for double code transmission. In this case, a given order code is sent out and repeated after a short interval. At the satellite, the reception of the first code establishes a preliminary path and the reception of the second code, if identical with the first, results in the desired operation.

Transmission. Optional arrangements are provided which permit the *SC2* signals to be transmitted over all types of outside plant facilities. These include d-c loops, narrow-band telegraph channels, toll type signaling circuits, and voice channels. Only one channel is required for an entire *SC2* system. Signaling speeds of 10 or 25 pps are available. Thus, it is possible for the customer, by using the 10 pps speed, to sacrifice speed for economy where he so desires.

EQUIPMENT

EQUIPMENT COMPONENTS, relays, resistors, capacitors etc., are of proved reliability in Bell System telephone operation.

The equipment for the main, satellite, and monitoring stations for both switching and power is mounted in 7-foot steel cabinets with doors on front and rear. Consoles for main control panel and monitoring display panel are floor supported cabinets approximately 4 feet high with sloping face for the control keys and display lamps. All equipment units with the exception of an auxiliary roll call panel are of plug-in type and may be quickly replaced to facilitate maintenance. The receptacles for all plug-in units directly associated with remote control operations are universally wired and, thus, provide a high degree of flexibility.

Your Next Step REGISTRATION

A. E. PAIGE
MEMBER AIEE

Engineering, along with medicine and law, is a profession entrusted primarily with responsibilities incident to activities dealing with the protection of life, health, rights, and property. Registration of all eligible engineers as Professional Engineers is important not only to the individual engineer, but also to the prestige of the profession.

IN THIS AGE of "sputniks" and at a time when there is grave concern about our scientists and engineers, we electrical engineers should do all in our power to help alleviate the situation. Even where required as a protection to the public, registration as a Professional Engineer will raise the prestige of the engineer as well as establish his legal status.

The Engineers' Council for Professional Development through its Recognition Committee, in a letter from its chairman G. H. O'Sullivan, has proposed the following definition of engineering:

> "Engineering is the profession in which a knowledge of the mathematical and physical sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the progressive well being of mankind."

This definition clearly states that engineering is a profession and must take its place along with all other learned groups such as medicine and law. Hence, we as engineers should become Registered Professional Engineers the same as the other groups are registerd in their respective fields.

Modern civilization has found it necessary to regulate the practice of persons whose activities deal with the protection of life, health, rights, and property.[1] Engineering, along with medicine and law, is entrusted primarily with the responsibility incident to these activities. Today, every state, territory, possession, and district of the Nation has a statute defining and governing the

A special article prepared at the request of the AIEE Registration of Engineers Committee to further the AIEE policy recommending the registration of engineers.

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practice of engineering. From the time the first engineering registration law was passed in Wyoming in 1907 until the end of 1956, approximately 215,000 engineers have taken steps necessary to become registered and can now call themselves Registered Professional Engineers.

Registration establishes an engineer's legal position. An engineer may find it highly desirable to be registered, even though his present position does not require registration. Many engineers have moved from one employment into another or into engineering practice and have found their way handicapped by failure to obtain registration at an earlier date. In some companies, professional registration is required before a man is advanced to an administrative position.

Ohio University made a "man on the street" survey in which one of the major questions dealt with community prestige of the engineer as compared to seven other professions.[2] The high school student rated the engineer second while the adult group rated him sixth. In order to maintain this rating with the student and improve our rating with the adult, we must let the community know who we are and what we are doing. Unquestionably, we would gain prestige if our neighbors knew we were registered as are those in other professions.

EXAMINATIONS

THE PRESENT TREND is toward requiring all engineers to take an examination before becoming registered. As time goes on, the requirements for registration will, without question, become more and more stringent. Many engineers may find it more difficult to pass these examinations in the future. The sooner an engineer applies for registration following his graduation from college, the less burdensome it will be for him to prepare himself for these necessary examinations. In many of our universities and in some of the larger cities, the engineering societies, or other organized groups, are offering refresher courses which are very helpful in preparing a man who has been out of college for a period of time to pass the examinations.

When you entered college as a freshman in electrical engineering, you made the decision to be an engineer. As an engineer, you wanted to advance in your profession and be looked up to in your community. Therefore, it is essential that in order to accomplish this ambition you should be registered as a Professional Engineer.

The most opportune time for the young engineer to take and pass the engineering sciences portion of the examination is at the time of graduation. He is accustomed to taking examinations while in college and the basic sciences are fresh in his mind. He should find it much easier to pass the examination at the end of his academic studies rather than after he has been out of the classroom for several years. The examinations vary with the individual states. However, in general, the examining boards are interested in knowing the applicant has acquired the basic knowledge in the fields of mathematics, chemistry, physics, analytic mechanics, strength of materials, fluid mechanics, elementary thermodynamics, and basic electricity. At that time, if he passes the examination, most states issue a certificate entitled "Engineer in Training." After several years (generally four) of practice, he may complete his professional engineering registration by demonstrating that he has obtained the required experience and knowledge of his chosen field. In most states, this demonstration of professional experience and knowledge is by further examination.

Your State Board of Registration can give you details as to when and where the examinations will be given. If you do not know the address of your State Board ask your local AIEE Section Chairman or write the National Society of Professional Engineers, 2029 K Street, N.W., Washington 6, D.C., and ask them for a copy of their brochure, "Next Step Registration." *Don't procrastinate any longer, register now.*

REFERENCES

1. Next Step Registration (pamphlet). National Society of Professional Engineers, Washington, D.C.

2. Ohio University Man-on-the-Street Survey Reveals Impressions of P.E.'s, Other Professionals. *American Engineer*, Dec. 1956, pp. 16-18.

Dual-Cooled Power Transformers

Recently installed at Philadelphia Electric Company's Eddystone station, the world's first dual-cooled power transformer system will use two Allis-Chalmers 200,000-kva power transformers equipped with "Electro-Cooler" units. The arrangement will enable the utility to continue to carry full nominal generator output on one of the transformers should the other be taken out of service. With the trend to higher kva ratings in transformers, use of twin units will simplify transportation, handling and installation, and give better continuity of high-efficiency generation.

Thermal Analysis of Transformer Load Cycles

SAUL BENNON
MEMBER AIEE

MANY TRANSFORMERS are called upon to supply varying loads in normal service. In some cases these loads are cyclic in nature. After one or more cycles the thermal response of the oil and windings will also follow a repetitive cycle.

In general, the variation in load during a cycle can be approximated by a series of steps of constant load. For example, Fig. 1 illustrates a load cycle consisting of loads $P_1, P_2, \cdots, P_n$ for time intervals $\Delta_1 = t_1$, $\Delta_2 = t_2 - t_1, \cdots, \Delta_n = t_n - t_{n-1}$. The evaluation of winding rises during such a cycle can usually be reduced to the problem of establishing the oil rise variation. This is true because the winding rises, above oil temperature at constant load, are established in a matter of minutes after which the winding rise essentially parallels the oil rise. After the oil rise cycle has been established, the winding rises can be obtained by adding the winding rises above oil corresponding to the various load steps.

The conventional approach in establishing the final oil rise cycle is to assume an initial oil rise and evaluate the oil rise changes produced by the successive steps of load. This is done using either the conventional exponential formula or special exponential graph paper. If the calculated oil rise at the end of one load cycle differs from the value initially assumed, the calculations are repeated using this new value. This procedure is repeated until the initially assumed value and the final calculated oil rise of the cycle are equal.

Actually, it is possible to evaluate the oil rises corresponding to the end points of each load step directly without repetitive calculation by using the following equations for an n-step load cycle

$$\theta_x = \frac{1}{K'_n - 1} \sum_{r=1}^{n} \theta_{ru}(K'_r - K'_{r-1})$$

$$\theta_r = \frac{1}{K'_x}\left[\theta_o + \sum_{r=1}^{x} \theta_{ru}(K'_r - K'_{r-1})\right]$$

$$K'_r = e^{\sum_{r=1}^{r} \frac{\Delta_r}{\tau_r}}$$

θ_o = Initial oil rise.
θ_x = Oil rise at end of load step x.
θ_{ru} = Ultimate oil rise at load P_r.
Δ_r = Duration of load step P_r.
τ_r = Effective time constant during interval Δ_r.

For forced-oil-cooled transformers, the value of τ_r can be considered constant. However, for the more general case, the value of τ_r for each load step can be approximated by

$$\tau_r \cong \tau_N \left[\frac{\frac{\theta_{ru}}{\theta_N} - \frac{\theta_{r-1,u}}{\theta_N}}{\frac{W_{ru}}{W_N} - \frac{W_{r-1,u}}{W_N}}\right]$$

where

τ_N = Nominal time constant for rated load starting from zero initial oil rise.
W_N = Transformer loss at rated load.
θ_N = Transformer oil rise at rated load.
W_{ru} = Transformer loss necessary to produce steady oil rise θ_{ru}.

The oil rises at the end of the load steps are generally the most critical points in the cycle, because they include

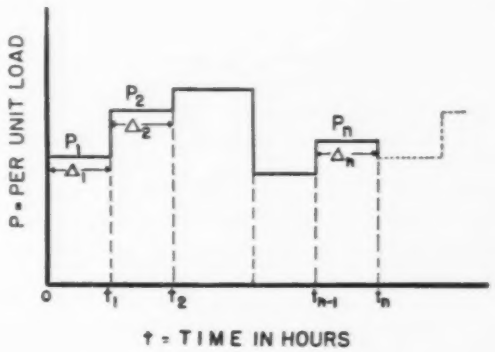

Fig. 1. Load cycle consisting of constant load steps.

both the maximum and minimum oil rises. If the complete transient cycle is required, the terminal oil rises obtained can be used in the conventional exponential equation for each load step.

There are many load cycles for which the time of occurrence of the maximum oil rise can be determined by inspection. In these cases the reference or zero time can be chosen so that θ_o becomes the maximum oil rise.

It is also possible to obtain a close approximation to the average oil rise during a repetitive load cycle. This is given by

$$\theta_{avg} = \frac{1}{t_n} \sum_{r=1}^{n} \theta_{ru}\,\Delta_r$$

This equation while derived for forced-oil-cooled transformers still gives a good approximation for all types of cooling.

Digest of paper 58-55, recommended by the AIEE Transformers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 2-7, 1958. Scheduled for publication in AIEE *Power Apparatus and Systems, 1958.*

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Presently Available Tools for Information Retrieval

JACOB RABINOW

The nature and quality of the information and needs of the researcher are important factors in the efficient use of retrieval tools. Their potentialities and limitations in the art of information searching are reviewed.

BEFORE ONE CAN LIST the tools for information retrieval, it may be well to state that there is no simple or clear-cut definition of information retrieval. The information itself can be of a general nature which is already available in libraries or in similar files, or it may be information specially arranged for mechanical retrieval, or it may well be a combination of both. The retrieval tools have to be considered in the light of not only the nature of the information being searched, but also the nature of the wishes of the searcher. This means that the same information may be searched in many ways by different users. In a library, for instance, one may want to find a specific answer to a specific question, such as: the melting point of a particular alloy, or the study of alloys in general, or merely collect a bibliography of papers pertaining to alloys. It does not necessarily follow that one who collects a bibliography would like to read the papers and the books so listed.

Sometimes, the information sought is very short; for example, finding a telephone number that corresponds to a particular name or a particular address. Sometimes, the information may represent a large collection of volumes of books.

The information may be searched for specifically; that is, one may want to find a specific patent identified by number or one may want to search for a patent by the subject matter. Sometimes the subject matter sought is very specific and clearly defined and sometimes it is quite vague—one does not know in which art or in which group of patents the information will be obtained. It is in these subtle searches where the prior definitions are not good enough or specific enough that most of the systems break down or at least become difficult.

Information may also be of various types. It may be susceptible to simple coding, particularly if the information is already in the form of words or numbers. On the other hand, some information must be searched as pictures. This type of data lends itself more to facsimile reproduction. This would be the case in searching for specific fingerprints, for documents which contain important signatures, and for information which contains photographs or other pictorial matter. It may be argued that all such data can be converted to numerical bits. Perhaps so, but at the present stage of development converting a signature or a picture into equivalent bits and searching it by numbers is so tedious and difficult a project that it is not being attempted seriously.

When mentioning the available tools, one can simply state that there are very few tools available today designed for efficient information search. A great many tools are being worked on so that, in the foreseeable future, information search will really hit its stride. I would like to list, with some comments, the things that have been done and that are now being done and try to put them, more or less, into an understandable sequence.

At the present state of the art, it is quite possible to do extensive but not necessarily very sophisticated searching of information. Unfortunately, the high-powered techniques require very expensive equipment and they have not as yet proved themselves to be economically competitive with the human searching that is done in libraries, patent office files, and so on. It is true, unfortunately, that our libraries, which are the large depositories of human knowledge, are also among the least wealthy of our organizations. Therefore, it is difficult for them to obtain or experiment with high-powered machinery.

The value of rapid search is uncertain at the present time because the value of rapid delivery of information to a human is unknown, except in some very special definite cases. If one could get the information more quickly, could one digest it? Would it save appreciable time in the ultimate work in which the human is engaged? In the case of research in science, it is hard to say how much can be saved in the long run by more efficient and faster delivery of information. How much of scientific progress results from laborious physical and mental problems of research, and how much would be gained by fast availability of data?

Almost without exception, all present-day information storage systems are based on descriptors of some type. These describe the document or the subject matter. These descriptors are usually words. In one case, where a search of chemical patents is being worked on at the National Bureau of Standards (NBS), relationships between descriptors are also being inserted.

Essentially full text of a conference paper presented at the AIEE Summer General Meeting, Montreal, Quebec, Canada, June 24-28, 1957. Recommended for publication by the AIEE Computing Devices Committee.

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PUNCHED CARD DEVICES

THE SEARCH for documents by descriptors can be done in many ways. The most common and the oldest, of course, is the use of punched cards, in one form or another. One advantage of punched-card techniques is that it is easy to insert additional information into the file. The cards can be arranged at will and the amount of information stored is quite considerable. The file, of course, can be expanded indefinitely. The subject can be inserted into cards by direct number or by descriptors, or by any combination, and the search can be made directly, if the cards are in an ordered array. One can go more or less directly to the card and look up pertinent information, or if necessary, one can search the whole file for those descriptors which fit the search. All sorts of logical combinations can be arranged so that only those cards that satisfy several requirements will fall out or at least be noted. The disadvantage of these systems is that in the original punched card techniques using standard cards, the search is serial, and a large number of cards must be handled in order to find the one that is desired.

Parallel look-up systems of punched cards have also been devised. The subject matter is assigned to one card, and a descriptive code is converted to notches along the edges of the card. Putting an array of such cards over suitable mechanical pins, one or more cards can be made either to drop or to rise above the others. Once the card is lifted, one can get the information itself or an index to the information from the card.

It will be noted that such schemes of cards require a large number of cards for a large number of information entries, or units. For example, if 10,000 abstracts are to be searched, 10,000 cards must be searched.

The edge-notched cards have a limited number of codes possible and in order to increase the coding possibilities, Calvin Mooers devised the Zator system where the code numbers are converted to random numbers so that a large number of interlaced numbers can be handled and the number of "meaningless" cards selected is kept to an acceptable minimum.

The McBee card system is perhaps the best known of the straight edge-notched systems used in the United States.

Another form of hand-sorted punched cards is that developed by Batten in England and, recently, given considerable publicity as the "Peek-A-Boo" system of the NBS. In these systems, advantage is taken of the fact that the number of descriptors in an art is always less than the number of information items. In other words, a language has less words than books or papers written in that language. In these schemes, a card is assigned to a descriptor, for example, the topic "Plastics." All documents in the system have a unique serial number and each number has a unique reserved spot on all of the cards in the system. A hole is punched in those cards that bear on the particular document, the hole being in the identical reserved location for that document. Thus, a paper may be item 99 on cards "Plastics," "Manufacturing," "Canada." When one wishes to know what documents there are on "Manufacturing of Plastics in Canada," one selects those three cards and superimposes them. Hole 99 will pass light and thus identify this document. A needle can be used as an alternative probe instead of light.

Documentation Inc. of Washington, D. C., has devised an improved form of such systems in which the "reserved-spot" feature of the Peek-A-Boo device is eliminated. The cards still pertain to a single descriptor, called a "Uniterm," but the identifying number of the document is printed in one of ten columns on the card, arranged by the last digit. It is a relatively easy matter to scan two cards by eye and pick up the number common to both. Then the search can be made on more cards and the number common to a group of cards can be found. In some of their equipment, mechanized versions of the Peek-A-Boo type of systems can be obtained. They have refined the system still further and are designing equipment that uses letters of the alphabet rather than words as the identifying code on a card. The claim is made that by using a relatively small number of cards a very large number of information items can be searched. These parallel card searches, thus far, have not been extended to a very large number of cards. They work where the number of cards is of the order of thousands or hundreds. The system becomes fairly unwieldy when the number of information items runs into the hundreds of thousands and millions.

PHOTOGRAPHIC AND OPTICAL TECHNIQUES

IN THE PUNCHED CARD SYSTEMS of information retrieval, the information received directly is not usually the actual document. Generally speaking, often only an index as to where the information itself is located is provided. Sometimes an abstract is available. In a "FilmSort" device, a microphotograph is attached to a standard punched card. One searches by a punched card mechanism, and one can then get the document when the card is selected. The document can be reproduced photographically or examined directly on the card.

Higher speed devices use microphotographs and photographic dots for coding. The advantages of these units are: first, the large reduction of volume required for storing information; and, second, the high speed at which the particular data can be searched. For instance, on the "Rapid Selector," which will be described later, it is possible to search at the rate of some 300 documents per second. There is no reason why this speed cannot be increased. In the new "Minicard" system being developed by Eastman Kodak, the documents are on discrete pieces of film which slows their search if used in a purely serial form; but one gains the advantage that one can go directly to a particular group of cards if one knows the identity of the document.

As in the Rapid Selector, when the information is found, it is available for photographing so that it can be reproduced quickly and one does not have to go to a second file to finish the search. The rates of search

are something of the order of 20 small cards per second. The advantage of using small cards, as in all such discrete systems, is that one can insert new information or rearrange the old information as often as one wishes.

It is recognized that searching by a single descriptor is a rather crude method and that searching by combinations is desirable. The new machines are designed to do so. Of the two experimental models of the Rapid Selector, the first was built by Engineering Research Associates for the Department of Commerce, and the second was built at Yale University. The latter has not been completely finished and is now in the works at the NBS. The first machine was characterized by the fact that each particular document on the film was identified by six numbers (or descriptors), any one of which could be looked for at a time. The second machine is characterized by increased flexibility in that the entry can be identified by any combination of descriptors and the number of descriptors can be as large as one wishes. Also, one can use logical product, logical sum, and so on, of the descriptors so that one can find a document described by one descriptor but not by another.

There is also the optical disc storage system of the International Telemetering Corporation. This system records information in a binary form on high-speed optical discs, which are searched by a flying spot scanner, so that one can select a particular row of dots at high speed and read them out by means of photocells. This type of storage can search tremendous volumes of data exceedingly fast and requires high-powered electronic equipment at the output of the photocells to digest the information. As far as I know, no such machine has yet been put into operation.

There is a device being developed by R. H. Bauman of Massachusetts Institute of Technology which employs optical 4- by 4-inch cards which record ½ by 2-mil dots, for which the readout rate is going to be about 1 million words per second.

MAGNETIC TECHNIQUES

THE MAGNAVOX CORPORATION is now developing a "Magnacard" system which consists of a drum carrying magnetic cards. There can be something of the order of a billion bits in a single file. The read-out rate is about half a million cycles per second.

There are, of course, the possibilities of storing information on magnetic drums and tapes. These are particularly attractive for those files which have to be changed often. Such information can be rearranged by high-speed computers without deterioration of quality because it is re-recorded. This is not, generally speaking, true of information stored optically on photographic discs, films, or cards. In the case of digital dots on film, these could conceivably be regenerated and reproduced indefinitely without deterioration.

There are a great many companies that produce magnetic tape and the equipment that goes with it. Among these, of course, are International Business Machines Corporation (IBM), Remington-Rand, Ferranti, and many others. For rapid search and, particularly, for random access, there is a growing series of devices in which shorter and more films are used. Among such things is the Pike's Peak at the NBS where the film is not put on reels but is dropped into "baskets" and the retrieval is quite fast. Such devices are also now being built by Potter Instrument Company and by Burroughs in their ElectroData Division. The Burrough's "Data-File" consists of short tapes with a traveling magnetic head assembly that can select a particular strip of magnetic tape and record or read quite quickly.

Going from continuous tapes and drums, one gets to combinations of these like the "Tape-Drum" of Brush which employs a wide tape passing over a drum, thus combining the speed of a drum and the large capacity of a tape. The proposed model has 128 heads across the tape and runs at 1,200 rpm. The amount of information stored is, of course, quite considerable. Then there is the magnetic disc RAMAC of IBM. This is in production. It employs 50 discs and the proposed new models will employ more. The magnetic heads are kept from contact by air pressure, and the machine itself resembles a giant juke box. Because of the noncontacting type of operation, the discs should last indefinitely. The storage density is quite typical for this sort of recording, being between 50 and 100 dots to the inch, 100 tracks to each side of a disc. Both sides of the disc are employed. At one time, the NBS made some experimental models of a "Notched Disc Memory" using an array of magnetic discs with notches, or pie sections, removed from each disc. It was possible to stack a lot of information in a relatively small volume. There was very little support for the work and, at present, the work has been abandoned. Some of the features of the servo system and the air support for the heads with which I was concerned, are also found in the IBM RAMAC.

In summation, if I were asked to list the units available at present for information retrieval, I would list the various standard card sorting equipment, although this equipment is not specially designed for this job. The special equipment includes the Uniterm systems of Documentation, Inc.; the Edge-Notched cards of McBee and others, the Zato-coding systems, and the various Peek-A-Boo systems. There are many systems in development. Among the leaders is the miniature card system of Eastman Kodak Co., and others mentioned earlier.

CHARACTER RECOGNITION DEVICES

I WOULD LIKE TO TOUCH on the newer field of searching printed information directly by character recognition machines. There is a great deal of work being done now, particularly in the United States and perhaps elsewhere, on the reading of printed characters. Handwritten material is too formidable a problem because it would be hard to have a machine read my handwriting, for example, when very often I cannot read it myself. The leader in this field is the Intelligent Machines Research Corporation, Arlington, Va., which

has built and delivered machines that can read typewritten or printed characters. They are now working on machines to read a variety of addresses on first-class mail. Machines of this type are also being developed by IBM, Remington Rand, Burroughs, Laboratory for Electronics, the staff of the Stanford Research Institute, the NBS, and my own organization.

These machines work on various basic principles. The machine of the Intelligent Machines Corporation uses a scanning technique which converts the characters into a series of electrical pulses which then are analyzed and decoded by computer techniques. The output can be a printer or a card punching device or anything one wishes. The machinery developed by the Stanford Research Institute, now called the ERMA system, employs characters printed in magnetic ink. These are sensed by a single wide magnetic head that moves over the characters. Each character produces a unique wave shape which is analyzed by an "optimum match" technique. Incidentally, the optimum match technique was used for the first time, as far as I know, in a machine built at the NBS. In this system, the machine does not say that a particular character is the number 2, but it says that this is more of a 2 than any other character. The ERMA system suffers from the limitation that the wave shapes resemble each other and it is doubtful that, without serious modification, the system can be made to read alphabetic characters as well as numerals. The system has been adopted by the American Banking Association because of its simplicity and high speed, and is going into large-scale production.

Among the advantages of this system, in addition to its high speed, is the fact that overprinting, pencil marks, or other smudges overlaying the magnetic characters do not adversely affect the performance of the reader. Reading rates at over 1,000 characters per second have been achieved.

Other systems read characters by scanning them with an array of photocells which send their signals to some sort of a computer device. The machines at the NBS and at our plant use an optical match technique where a character is projected onto a mask which is then scanned. The output of the scanning system determines how much mismatch there is between a character and each of the many masks. The best match determines the character.

In most of the reading machines, the great difficulties are the complexity of the equipment and the difficulties with positioning the character. In some techniques, particularly that of IMR and the ERMA system, the vertical variations of position of a character within certain limits gives little trouble. This is more difficult in the optical match of my device. Reading speeds of the order of 1,000 characters per second are required because the machines have to match the handling speeds of IBM and other punched card machines which operate at the rate of approximately 10 cards per second. Each card may carry about 100 characters on a single line. There is no reason why such machines should not read characters at a much higher rate eventually. The output of such readers is obviously not intended for human consumption but, rather, goes directly into other machinery. This is a case where machines read to other machines.

There is another pertinent field of electronic devices and that is the transmission of information by television techniques. There is no doubt that in libraries of the future, such equipment will be available. That is, one can envision a library where machines search for, identify the document, produce the document, place it before a television transmitter, and then show the image to the human searcher. The present television techniques are not quite adequate for good page reading but there is no reason to believe that this could not be done on closed circuit television. Certainly, if one wishes to read only a small section of a page, this could be done today. In order to conserve bandwidth, a great many developments are now taking place in which the transmission requirements need not be in the multimegacycle range, if one is looking at stationary objects. By using tubes, such as those developed by Hughes Aircraft Co., which can store an image for a long time, or by using other narrow-band storage techniques, it would be possible to transmit a great deal of intelligence over relatively simple lines. And if one then uses wide-band transmission lines, one could use multiplex systems so that many people could be served by one link.

For those who want to read an excellent discussion of the whole field of information retrieval, I highly recommend the preconference paper No. 6, "Report of the Committee on the Inventory of Methods and Devices for Analysis, Storage, and Retrieval," December 28, 1955, School of Library Sciences, Western Reserve University, Cleveland 6, Ohio.

GENERAL COMMENTS

I WOULD NOW LIKE to make some general comments about information retrieval. So far, no one has applied automatic search to large collections such as a large library or a main portion of the records at the U. S. Patent Office. The NBS is experimenting with searching chemical patents of a specific type by the SEAC computer. Here, not only is the information in specific form, but also the relationship between the units of information are specific and unique. That is, the diagram of an organic chemical formula can be expressed in mathematical terms. Therefore, the search for the whole or parts of it can be made by high-power computers such as the SEAC. It is hoped that mechanical designs, perperhaps, also could be so arranged as to be in such a schematic form that the relationships between elements also could be expressed in rigorous and unambiguous terms. This is now being looked into.

However, the things in the patent office that can be searched by machine, I believe, will remain for some time to come the elementary types which can be searched by humans without too much trouble. This does not mean to say that machines will not save time, but they will not find anything that the human won't find easily. When it comes to searching difficult art or difficult relationships that were not anticipated when

any particular coding was originally set up, machines will be in serious trouble. I would like to give an example of this. Some time ago, I was lucky or unlucky enough to invent a device called the "Magnetic Fluid Clutch," which consists of iron plates, some iron powder, and occasionally some oil. In searching for this, the patent office at first produced nothing. However, a few years after the patent was filed, they discovered that a coherer invented in about 1890 for the detection of radio waves used iron particles and used a magnetic field. Here were iron particles in a magnetic field, and the particles adhered to each other. This was cited against me as being a similar mechanism. We beat that down finally, but with some difficulty. It seems to me that no coding system set up in 1890 could possibly have anticipated that the coherer art would cross the power transmission field of 1948. Therefore, the only thing that was common was the fact that there was iron powder in the field. One could say that if every word in a patent were fed into a machine this would have been found. This is hardly likely. Because, if in searching for a magnetic fluid clutch, one were to get dumped into his lap (or more likely on the front lawn of his office) all of the patents that had something to do with iron powder and a magnetic field, one would have to start practically from the beginning and would have to read a good part of the patent office files. This sort of search would not normally help a man very much. The whole idea is to narrow the field down to a small number of specific things.

Other examples of this difficulty could be given where the related arts had different words; in fact, the concepts at the time each art was developed were different, but later people's minds recognized similarities. For instance, when negative feedback circuits were well understood, people noticed that the economic system of a country has many similarities to an oscillating amplifier, particularly where the system had high gain and considerable inertia. In talking about economic systems one does not normally talk about high gain, at least in the sense of an amplifier, and output inertia. Yet these things are there, and it is very difficult and often impossible to classify the present knowledge for the future search.

In the purely mechanical aspects of searching, in the field of rapid document handling, the machines can do a tremendous job, and this is the field where they should be applied first. You and I and everyone else many times have seen the situation where one reads a document and sees a reference, and wishes that he could get his hands on the reference immediately. Usually, by the time one does get the reference, days or months later, one has forgotten for what it was wanted and, because it probably was rather trivial in the first place, one never bothers to read it.

I would like to make this final comment: most searching devices today are based on the use of words to describe content. This is fine as long as the concept is so describable, but unfortunately the words often are of secondary value. In the mechanical arts, the picture usually is more important, and the words that describe it are by no means adequate. Some parts of the picture may not be described at all because they were considered trivial at the time the picture was drawn, but they may not be trivial at all many years later. Today, our machines are not geared to concepts other than words, and as long as this limitation remains, searching by the human mind that can store concepts which are not described in words—that can remember smells, sounds, and emotional effects—will remain incomparably better.

A-C Group Drives for Modern Textile Machines

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ASSOCIATE MEMBER AIEE

Electrical drive equipment has played a large role in modern textile machinery. The advantages of a-c group drives over d-c drives are presented with several examples given.

TODAY'S modern textile machinery is vastly superior to its counterpart of only a few decades ago. Greater production speed has been made possible. Quality of product is more effectively controlled. Increased flexibility is built into the equipment to provide more versatile operation. These factors, combined with greater reliability and reduced maintenance, result in more productivity and less unit cost of salable end product.

A large factor contributing to this progress has been the electrical drive equipment available to power and control new textile machinery. Historically, the replacement of lineshafting and belts by individual motor

drives was probably the first innovation in this direction. More recently, the use of d-c motor drives has become widespread, largely because of the flexibility of controlling motor speed for optimum production conditions. Processes requiring close control have added modern regulators to the d-c drive to provide automatic surveillance of operation.

ADVANTAGES OF A-C GROUP DRIVES

PERHAPS LESS WELL KNOWN in this drama is the part played by the modern a-c group drive. The co-ordination of several motors on a single textile machine leads naturally to the consideration of a single control and power supply of all motors, especially if the power supply is made versatile. The use of a generator whose frequency can be varied over a wide range, provides an extremely flexible and co-ordinated control of an entire machine. Smooth and uniform acceleration of all motors simultaneously is a simple matter. In addition, the separate a-c generator permits operation of a-c motors at speeds much greater than those obtainable from a 60-cycle supply.

Further advantages of a-c group drives are found inherently in the consideration of a-c motors vs d-c motors. Squirrel-cage induction motors, for example, are extremely rugged and capable of withstanding much more abuse than d-c motors. Maintenance requirements are greatly simplified by the absence of brushes, slip-rings or commutators. Operating speeds of the a-c motor are limited only by mechanical considerations, whereas brush wear and commutation of d-c machines impose a much lower limit.

MOTORS FOR A-C GROUP DRIVES

ALTHOUGH squirrel-cage induction motors are perhaps most commonly used with a-c group drives, small synchronous motors are frequently employed where absolute synchronism between machine sections is essential. Because horsepower requirements are normally small, say less than 15 hp, the conventionally excited synchronous motor is uneconomical. Instead, synchronous reluctance motors are used construction features of which are essentially the same as the squirrel-cage motor. A specially shaped rotor punching is used to obtain good synchronizing torque, but otherwise the appearance is unchanged. Sometimes permanent-magnet synchronous motors are used to provide improved power factor and efficiency, especially in fractional horsepower ratings.

Regardless of the type of motor used, either induction or synchronous, it is important that the proper voltage be applied at different frequencies. Best results are obtained by keeping the volts-per-cycle (vpc) constant. This produces the normal value of flux in the motors, and permits the motor to develop its full torque capability at all speeds. Thus, a motor rated 220 volts at 60 cycles should be operated with 330 volts at 90 cycles, 110 volts at 30 cycles, and so forth. If the voltage is reduced below the recommended value, the motor will be unable to develop its rated torque. If the voltage is excessive, the motor may draw excessive current and overheat.

POWER SUPPLY FOR A-C GROUP DRIVES

FORTUNATELY, it is very easy to produce constant vpc power with most adjustable frequency supplies. Either an a-c generator or induction frequency changer inherently produces a voltage which varies with output frequency. The frequency, of course, is varied by varying the speed at which the machine is driven by its prime mover. The prime mover may be any kind of adjustable speed drive, such as a steam turbine, gear changer drive, mechanical speed adjuster, or precision-controlled d-c drive. The selection of the prime mover normally will be dictated by economic considerations, or special application requirements.

Selection of an induction frequency changer or an a-c generator may also be determined by special application requirements. Although the frequency changer will normally have a lower first cost, there are two major limitations to its use. First, the output frequency of this unit cannot be exactly equal to line frequency. For example, a frequency changer operating from a 60-cycle input would not be able to produce output frequencies between about 55 and 65 cycles. For applications not affected by this "dead band," the induction frequency changer may be well suited. On the other hand, acceleration of a group drive from low speed (less than 60-cycle speed) to high speed (greater than 60-cycle speed) would prohibit the induction unit with its "dead band."

The second limitation of the frequency changer is that there is no inherent voltage adjustment. Voltage adjustment can be quite important when operating at low frequencies and, hence, low voltages. Under these conditions, it is desirable to boost the supply voltage in order to compensate for line voltage drop, which may now be a large percentage of the applied voltage. This compensation is necessary to insure constant vpc at the motor terminals.

APPLICATIONS OF A-C GROUP DRIVES

CONSIDERING THE NATURE of many textile machines, it is not surprising to find the a-c group drive applied predominantly in this field. First, the drive has essentially a constant-torque capability at any speed or frequency. This naturally matches the loading of most textile machinery, which is characterized by friction (constant-torque) of spindles, drawrolls, beams, etc. Furthermore, there are any number of machines which are comprised either of sections which must operate

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together, or of a multiplicity of sections all doing the same job.

An early application of the a-c group drive was for the spinning and processing of viscose rayon. Fig. 1 shows the spinning machine with its multiplicity of Godet wheels and spinning pots. The pot spinning motor designed especially for this application is required to operate at very high speeds, to be separately started and stopped for doffing, and to withstand a terrific mechanical and corrosion problem. Induction motors operated at high frequency fulfill all of these requirements in a straightforward manner.

Other textile fibers are spun on machines such as the Foster winder shown in Fig. 2, which utilizes an a-c group drive for other reasons. The process requires extremely close quality control, with all motors perfectly synchronized and their speed held within very close limits. Thus, individual synchronous reluctance motors are used, supplied from a common alternator the speed of which is very precisely regulated. Since operating frequencies may be as low as 10 cycles, the alternator is controlled to boost voltage in this low range.

An important application in the field of yarn winding or packaging is a special drive for controlling the pattern with which yarn is laid back and forth across the face of the package as it is formed. Conventional motions often give rise to a "ribbon" effect, where the winding pattern repeats. If the speed of the yarn-laying motion is continually varied in a random fashion, these "ribbons" can be avoided, thereby permitting a larger and more properly formed yarn package. Thus, the motors which provide the yarn-laying motion are all grouped on a single power supply with frequency continuously varied to provide the random effect. Induction motors are entirely satisfactory for most requirements, and the group control provides simple co-ordination of the entire system.

Fig. 1. Viscose rayon pot spinning.

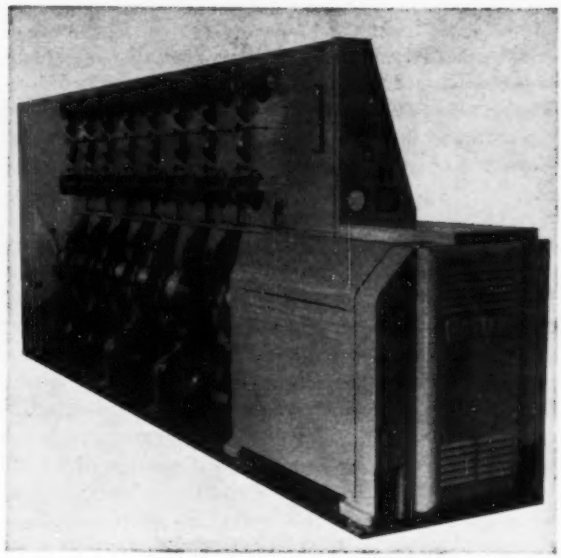

Fig. 2. Nylon spinning machine winder.

Perhaps, a more conventional application is the Abbott automatic quiller which is used to fill empty loom bobbins with a minimum of operator attention. Each winding station is individually motorized with a small induction motor, and all stations revolve together past loading and unloading points. All motors are supplied from a common induction frequency changer, which runs the motorized spindles at high speed as required by the type of yarn used. Not only can the spindles be run at high speed, but also use of an electric drive facilitates the transmission of power to the moving stations.

CONCLUSION

Although several examples have been given of machines using a-c group drives, the surface has just been scratched. The further development of modern textile machinery is already pushing spindle speeds to the point where conventional tape or other drive transmissions are no longer suitable. Consideration already is being given to the use of individual a-c motors for the spindles of new high-speed twisters. It is expected that future progress in fiber and machine design will uncover many additional uses of a-c group drives for other phases of the textile operation.

Valve Point Loading of Turbines

G. L. DECKER A. D. BROOKS

A TURBINE loaded at a valve point, that is just before the next valve opens, is working at maximum efficiency at that loading. A turbine operating off a valve point is operating less efficiently because of the throttling of the steam passing through the throttled control valve.

Therefore, if all paralleled turbines are loaded on selected valve points except for one turbine free to move under governor control to meet smaller variations in steam or power demands, it follows that maximum efficiency in power generation will result.

This article shows that the precise loading of turbines at selected valve points determined by a digital computer, gives more power per pound of steam than would result if the same turbines were loaded at equal incremental steam rates, in accordance with common practice.

The loading of paralleled noncondensing turbine–generators is important, as they average about ⅓ of the heat drop of a condensing unit. The loss of 1 to 2 Btu heat drop in a noncondensing machine is much more important than 2 to 3 Btu in a 300 to 400 Btu heat drop condensing unit.

The increase in power generation is estimated at 1.4 to 1.8% when loading a noncondensing turbine having a 100 Btu heat drop, at valve points instead of random loading on the actual looped performance curve.

Fig. 1, showing a plot of steam flow versus efficiency for a noncondensing turbine clearly shows the valve points and the significant reduction in efficiency between the valve points of a noncondensing turbine.

If the full turbine performance curve is desired, it is necessary to establish the complete looped efficiency curve by running an incremental efficiency test. Such a test has sufficient load points to plot a looped efficiency curve similar to that in Fig. 1.

Why there may be a wide deviation from the turbine guarantee curve when testing a turbine generator also is shown in Fig. 1. A turbine test point can be above or below the smooth average of the loops guarantee curve, depending on whether it is on a valve point, or in between valve points.

Two or more paralleled turbines having performance curves with increasing incremental steam rates, would be loaded at equal incremental steam rates, in order to maximize the power generation.

However, equal incremental steam rate loading presupposes that the turbine operates on the smooth, average performance curve and does not recognize the existence of valve points in the machine where the efficiency is higher than the average smooth curve.

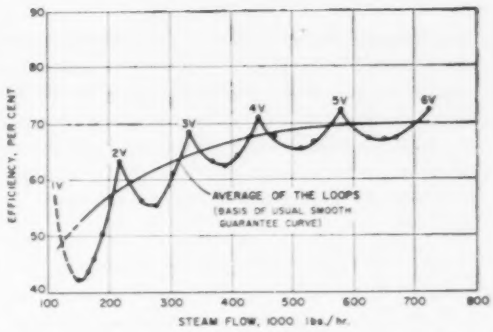

Fig. 1. Steam flow versus efficiency (noncondensing turbine).

In addition, equal incremental steam rate loading is not applicable to the economy loading of paralleled turbines if one or more of the machines has a decreasing incremental steam rate with increasing load.

All types of turbines actually have decreasing incremental steam rates between valve points, and equal incremental loading of paralleled machines using the actual curves will not readily yield the maximum power generation.

Because there is no direct mathematical solution for the optimum loading of three or more paralleled turbines on valve points, it is necessary to try all possible or practical loading combinations and compare the power generation per pound of steam.

A digital computer is a "natural" for a problem like this, because of its ability to do a large number of simple, repetitive additions, divisions, comparisons, etc., in a short period of time.

The accuracy of the computer print-out is the same as the data. The final values are absolute, and definitely show the loading on every turbine including whether it should be on or off. These solutions hold for a long time and do not have to be continuously resolved like an analog computer.

In summary, paralleled turbines should be loaded at selected valve points to maximize the power generation per pound of steam in preference to equal incremental steam rate loading using smooth average curves.

The fact that turbines should spend a major portion of their useful working life on valve points instead of in between them, poses a logical question for the turbine and equipment manufacturers. Can valves, valve gear, governors, and automatic dispatching equipment be adapted or redesigned to better fit and achieve this more precise and efficient valve point loading system for paralleled turbines?

Digest of paper 58-166, recommended by the AIEE Power Generation and System Engineering Committees and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Feb. 2-7, 1958. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1958.

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A New Microwave Antenna System

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Rapid expansion of radio relay facilities requires the development of new radio relay systems in the higher frequency bands assigned by the FCC for common-carrier use. To help meet this need, a horn-reflector antenna was developed. Its application, transmission characteristics, and general design requirements are set forth.

RADIO RELAY in the Bell System now provides over 7 million miles of two-way message circuits, approximately 1/6 of all the long-distance telephone circuits in this country. It also provides about 50,000 miles of broadband radio channels which make network television available to over 365 television broadcasting stations in 240 cities. This rapid expansion of radio relay facilities indicated some time ago that by 1955 portions of the central transcontinental and other backbone routes would be loaded to their capacity of six broadband channels in each direction of transmission.

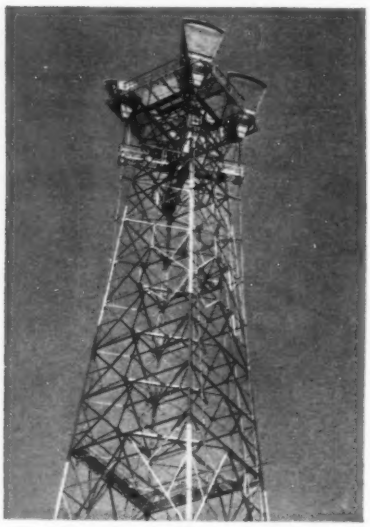

Fig. 1. Horn-reflector antenna installation at Terrell, Texas.

A new antenna called the horn-reflector antenna[1,2] and its associated circular waveguide were the first items developed for the needed higher frequency radio relay systems. The horn-reflector antenna and its circular waveguide are designed for simultaneous operation in the common-carrier bands of 3,700 to 4,200 mc (TD-2), 5,925 to 6,425 mc (TH), and 10,700 to 11,700 mc (TJ). The letters indicate the abbreviated Bell System code for the respective radio relay system, the latter two of which are under development. The 6,000-mc TH system will be a long-haul system with eight broadband channels in each direction of transmission, each channel capable of carrying about 2,000 message circuits or a monochrome or NTSC (National Television Standards Committee) color television program. The 11,000-mc TJ system will be a short-haul system, each broadband channel capable of carrying up to 100 message circuits or a monochrome or NTSC color television program.

Fig. 1 shows an installation of the horn-reflector antenna at Terrell, Texas, on the 4,000-mc TD-2 radio relay system from Atlanta to Dallas. The installation of this broadband antenna and waveguide promises considerable savings when 6,000-mc long-haul and 11,000-mc short-haul systems are added to this and other backbone routes in the future.

APPLICATION

FIG. 2 ILLUSTRATES that the horn-reflector antenna is basically an electromagnetic horn capped by a sector of a parabaloid shaped reflector. The apex of the horn coincides with the focal point of the paraboloidal reflector. This converts the spherical wavefront emanating from the feed horn to a plane or uniphase wavefront at the antenna aperture, thus insuring maximum gain and minimum side lobe radiation.

The feed horn at the focal point of the antenna is designed with the proper hyperbolic contour to match 2.812-inch inside diameter (ID) circular waveguide over the frequency range 3,700 to 11,700 mc. A circular copper waveguide with a 2.812-inch ID has three important advantages over rectangular waveguides: (1) the loss for the dominant TE°_{11} mode transmission at 4,000 mc is about 0.42 db per 100 feet, approximately one-half the loss of 2.290 x 1.145 rectangular copper waveguide; (2) two signals polarized at 90° to each other can be transmitted through a circular waveguide, and by careful control of manufacturing processes a cross-polarization discrimination greater than 40 db per 12½ foot section can be achieved; and (3) it is possible to transmit simultaneously dual-polarized signals in the 4,000-, 6,000-, and 11,000-mc common-carrier bands.

Propagation measurements over a typical radio link employing circular waveguide and horn-reflector antennas indicate that the net cross-polarization discrimination between vertically and horizontally polarized sig-

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nals is greater than 20 db. By alternately polarizing adjacent channels of the 6,000-mc TH system this 20 db of discrimination or selectivity can be used to reduce the spacing between broadband channels. As a result, a more efficient use is made of the frequency spectrum and a greater number of message circuits or television channels can be allocated in the 5,925 to 6,425-mc common-carrier band.

Because of their broadband characteristics, only four horn-reflector antennas will be required at each repeater station on main backbone routes to handle all three systems at 4,000, 6,000, and 11,000 mc. As shown in Fig. 1, a transmitting and receiving antenna will be used on main backbone routes for each of the two directions of transmission. On spur or light routes, where no more than three or four broadband channels are utilized in any one common-carrier band, one antenna may be used for both transmitting and receiving in one direction, thereby reducing to two the number of antennas per repeater station.

Fig. 3 shows schematically a horn-reflector antenna and circular waveguide system in which a finline[3] polarization separation network *A* may be used to separate the vertically polarized signals from the horizontally polarized signals in the 4,000-, 6,000-, and 11,000-mc systems. The signals then pass through system separation networks[4] *B*, *C*, and *D*, which separate the signals for each of the three common-carrier bands. Constant resistance networks[5] similar to those developed for the TD-2 system can then be used to separate the various channels in a particular common-carrier band.

The tuning section illustrated in Fig. 3 is used at the bottom of each waveguide run to improve the cross-polarization discrimination. It is a 12-inch section of waveguide purposely deformed to have a cross-polarization discrimination (XPD) of 25 db, a value approximating the net XPD of the antenna and a long waveguide run. As one of the final steps in the alignment of an antenna-waveguide system, the tuning section is rotated to improve the XPD to a minimum value of 30 db.

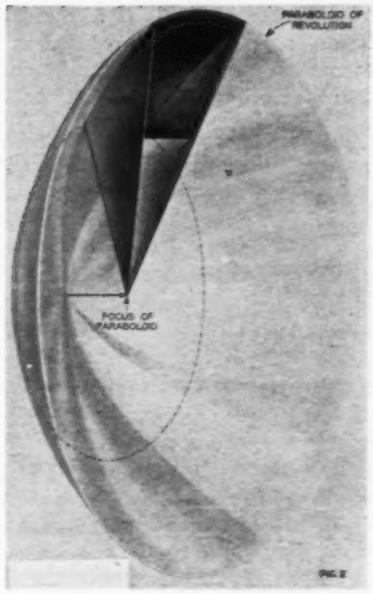

Fig. 2. Derivation of horn-reflector antenna.

Table I. Antenna Gain Characteristics

Frequency (mc)	Polarization	Midband Gain (db)	Efficiency in Db Down from Area Gain	Efficiency in Per Cent
3,950	Vertical	39.6	1.6	69
	Horizontal	39.4	1.8	66
6,175	Vertical	43.2	1.8	66
	Horizontal	43.0	2.0	63
11,200	Vertical	48.0	2.2	60
	Horizontal	47.4	2.8	52

Table II. Antenna Directivity Characteristics

Frequency (mc)	Polarization	Front-to-Back Ratio (db)	Horizontal Directivity (Azimuth in degrees)	Vertical Directivity (Elevation in degrees)
3,740	Vertical	71	2.5	2.0
	Horizontal	77	1.6	2.13
6,325	Vertical	71	1.5	1.25
	Horizontal	71	1.25	1.38
10,960	Vertical	78	1.0	0.75
	Horizontal	71	0.8	0.88

TRANSMISSION CHARACTERISTICS

Gain. The gain of the antenna with respect to an isotropic radiator or point source is shown in Table I. The efficiency of the antenna or the ratio of the measured gain to a computed area gain for the 64.5 square-foot aperture is also indicated both in db down from area gain and in per cent.

Horizontal and Vertical Directivity. Fig. 4 shows a typical radiation pattern on a 360° polar diagram for the horizontal directivity (azimuth) at 3,740 mc. The width of the beam between 3-db points at 3,740, 6,325, and 10,960 mc is shown in Table II. At the higher frequencies, the radiation patterns are similar to Fig. 4 except that even more of the energy is concentrated in the desired direction of propagation.

The vertical directivity (elevation) for both polarizations is also listed in Table II for the same frequencies.

The front-to-back ratio of the antenna, or its ability to discriminate against signals coming in from the back (180° response), can be taken directly from the horizontal directivity patterns.

New antenna measuring equipment has been developed which uses radar pulse techniques to achieve a higher order of accuracy in measurements of radiation patterns and crosstalk between antennas. In the past, measurements have been limited at times because of interfering reflections from nearby trees, buildings, and surrounding terrain. Magnetrons were developed for spot-frequencies in the three common-carrier bands, and by their use the aforementioned extraneous reflections can be separated from the direct signal on a time basis and, thus, a true plot of the radiation pattern and crosstalk can be obtained. However, the measured front-

to-back ratios in Table II or the crosstalk characteristics in Table III may be reduced at a typical antenna installation because of ground return or reflections from the surrounding terrain.

Crosstalk. The crosstalk or coupling between similar antennas in operating position at the same level on a tower is of particular importance when a two-frequency allocation plan is used for the radio system. In this type of plan, different frequencies are assigned for transmitting and receiving; but the receiving antenna pointing to the west received signals on the same frequency assignments as the receiving antenna pointing to the east. The same is true for the two transmitting antennas. Table III shows the measured back-to-back and side-to-side crosstalk of two antennas spaced on 20-foot centers. A pulsed test signal, at a known level, is sent into a transmitting antenna and the response or crosstalk is measured for different orientations of the receiving antenna.

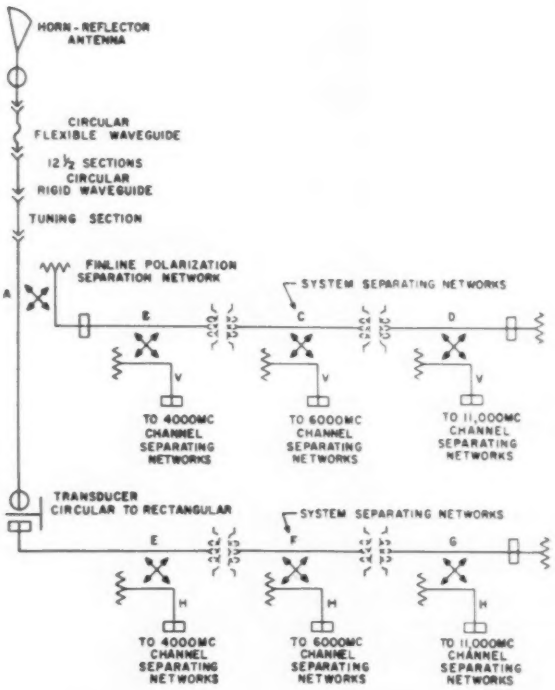

Fig. 3. Schematic diagram of circular waveguide systems for the horn-reflector antenna.

Cross-Polarization Discrimination. Cross-polarization discrimination of an antenna is a measure of the ability of the antenna to discriminate between two received signals at the same frequency that are polarized 90° with respect to each other. The maximum cross-polarization discrimination of the horn-reflector antenna is shown in Table IV.

Fig. 5 shows the cross-polarization discrimination of the main lobe of the horn-reflector antenna. Over the rest of the radiation pattern, the responses to vertically and horizontally polarized signals are approximately equal. The utilization of cross-polarization to discriminate against interfering signals is, therefore, not feasible except within the directivity of the main lobe. Fig. 5 also illustrates how rapidly the cross-polarization discrimination deteriorates if the antennas are misaligned or if their alignment is influenced by wind velocity, tower twist, or sway.

Table III. Antenna Crosstalk Characteristics

Frequency (mc)	Polarization	Crosstalk: Antennas Back-to-Back (db)	Crosstalk: Antennas Side-to-Side (db)
3,740	Vertical	140	81
	Horizontal	122	89
6,325	Vertical	140	120
	Horizontal	127	122
10,960	Vertical	139	94
	Horizontal	140	112

Return Loss or VSWR. One of the advantages of this type of antenna is its excellent return loss or low voltage standing wave ratio (VSWR) over the very wide frequency band from 3,700 to 11,700 mc. A good impedance match throughout the antenna-waveguide system is important in long-haul radio systems as the waveguide echoes, or reflections from an antenna at the end of a long waveguide run, may affect the message-handling capacity of the system.

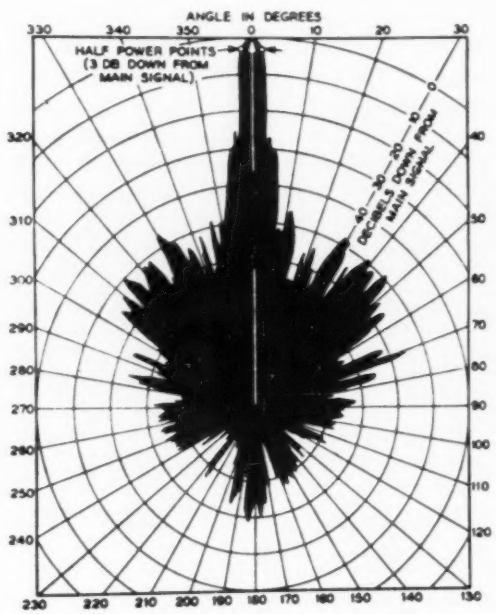

Fig. 4. Horizontal directivity of the horn-reflector antenna at 3,740 mc.

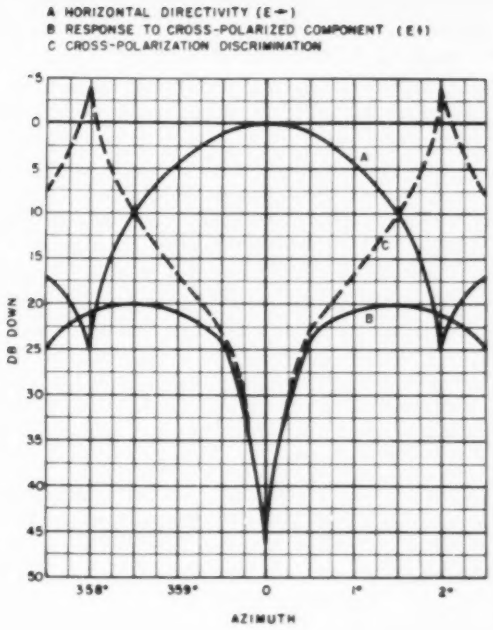

Fig. 5. Cross-polarization discrimination of the main lobe of the horn-reflector antenna.

The horn-reflector antenna tapers down with no internal projections to an aperture 11½ inches square, to which is attached a precision-cast aluminum feed horn. The internal contour of the 21-inch-long feed horn continues the taper in a gradual hyperbolic transformation designed to match the antenna into 2.812-inch ID circular waveguide over the frequency range 3,700 to 11,700 mc. The glass-fiber weather cover across the antenna aperture is sloped to minimize reflections back to the focal point or feed horn. The weather cover is designed to take heavy wind loads without any auxiliary braces or supporting structure, thus minimizing reflections from such sources.

The waveguide is drawn to precision tolerance, and each section is carefully fabricated and tested to insure that its return loss is 50 db or more (VSWR maximum = 1.0065).

Table V shows the minimum return loss of maximum VSWR measured for a representative antenna of this type with a 2.812-inch ID circular waveguide feed across the 4,000-, 6,000-, and 11,000-mc common-carrier bands.

FABRICATION

THE HORN-REFLECTOR ANTENNA is shown in more detail in Fig. 6. The antenna is mounted on gimbal supports on a square I-beam mounting frame which, in turn, swivels on a circular mounting base. Provision is made for ±5° adjustments in azimuth and ±3° adjustments in elevation angle.

The antenna weighs about 1,700 pounds and is 20½ feet high, 11 feet wide, and 9 feet deep. Its focal length is 7½ feet, and the front and side angles of the horn are 30°.

The sides of the horn are fabricated of 1/16-inch aluminum alloy reinforced by extruded aluminum "hat section" stiffeners.

The paraboloidal surface of the reflector is held to an accuracy of ±1/16 of an inch, which at the highest operating frequency of 11,700 mc is approximately ±1/16 of a wavelength. The reflector is fabricated in two parts with a dividing line from front to rear. A reflector skin for each half is formed by stretching a ⅛-inch aluminum alloy sheet over a glass-fiber reinforced plastic die having the desired paraboloidal contour. The reflector skins are attached to thick aluminum spars which have been routed to the desired contour. Formed horizontal ribs are attached in the reflector assembly fixture. Rather extensive tooling was developed to insure that the reflector surface was kept within tolerance and that the same parts of different antennas were interchangeable in production.

The antenna was designed to withstand heavy snow, ice, and wind loads of 100 pounds per square foot on flat surfaces, equivalent to average wind velocities of about 150 miles per hour. Static load tests up to 100 pounds per square foot were made on a preproduction model of the antenna, and the extensive instrumentation indicated that at this static load no part of the antenna was overstressed.

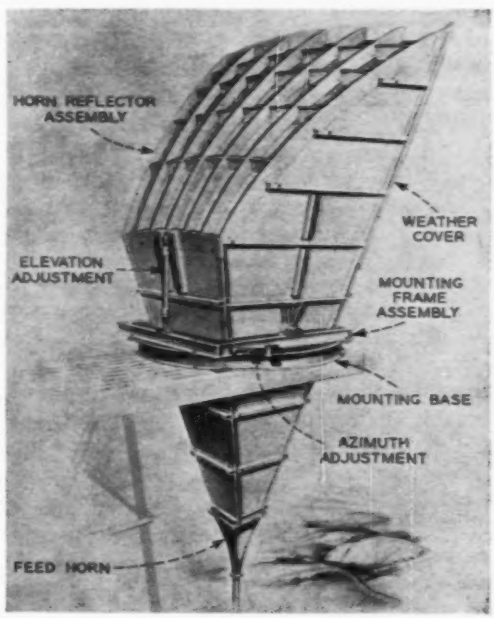

Fig. 6. General view of the horn-reflector antenna.

The 64.5 square-foot aperture of the antenna is protected from the weather by a four-ply polyester impregnated glass-fiber cover 0.040 inch thick.

All seams of the antenna are sealed against weather and radio-frequency leakage by a combination gasket

Table IV. Antenna Cross-Polarization Characteristics

Frequency (mc)	Cross-Polarization Discrimination (db)
3,740	46
6,325	51
10,960	53

employing nonvulcanized conducting rubber and a fine woven wire mesh. Though primarily a weather seal, the conducting rubber also provides an important secondary protection against the leakage of microwave energy. The antenna is substantially air-tight with a leakage rate of less than 15 cubic feet per hour. The antennas and waveguide at a typical installation are charged with dry air at a pressure of 30 pounds per square foot (0.2 pounds per square inch [psi]) from a silica gel dehydrator to prevent condensation from affecting the transmission characteristics of the antenna-waveguide system.

Table V. Antenna Impedance Characteristics

Frequency (mc)	Polarization	Return Loss (db)	VSWR
3,700 to 4,200	Vertical	43	1.015
	Horizontal	51	1.0055
5,925 to 6,425	Vertical	40	1.020
	Horizontal	48	1.008
10,700 to 11,700	Vertical	49	1.007
	Horizontal	47	1.01

The antenna is designed to be shipped from the factory completely assembled and pressure-tested, or packed in four boxes for field assembly at the repeater station site.

The waveguide is low-phosphorous, high-conductivity copper waveguide 2.812 $\pm$0.003 inches ID with a 3.000 $\pm$0.006 inch OD (outside diameter). The ovality or out-of-roundness is held to a difference of 0.004 inch between major and minor diameter at any point along the inside surface of the waveguide. A precision air gauge has been developed which makes it possible to insert a measuring head in the waveguide under test and to read directly on an external meter the ID of the waveguide. The measuring device is accurate to $\pm$0.0002 inch throughout its range of 2.812 $\pm$0.005 inches. Inasmuch as the cross-polarization discrimination is dependent upon the out-of-roundness of the waveguide, the air gauge is used by the drawing mill to check each length of tubing drawn. A corrosion-resisting steel flange is cold-headed on the copper waveguide which has had a slight shoulder machined on each end. An O-ring gasket is used between sections of waveguide to insure a pressure and weather-tight joint.

The use of the horn-reflector antenna, circular waveguide, and a new design of system and channel-separating waveguide networks promise considerable economies in the continuing expansion of Bell System long-haul radio relay facilities.

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Spectroscopic Plates Zero in Satellite Stations

More accurate tracking of earth satellites has been achieved in a U.S. Navy program with the use of special spectroscopic plates developed by the Eastman Kodak Company.

These spectroscopic plates, type *103A-F*, are used in astrographic or star cameras in the International Geophysical Year (IGY) program called Minitrack by the U.S. Naval Research Laboratory. The cameras accurately position radio satellite-tracking stations by photographing a flashing airborne light against a background of stars.

Time of the light flashes is controlled from the ground to within 1/1,000 of a second. When the position of the light is precisely determined by its distance from known stars recorded on a photographic plate, the exact location of the ground observatory antenna can be found by triangulation. This greatly improves the accuracy of subsequent satellite tracking by radio beam.

Royal-X Pan film, is used in the equally important "Operation Phototrack," where amateurs take Sputnik photographs at an exact time to determine a satellite's orbit.

Other extremely accurate cameras for obtaining timed photographs employ a 55 mm cinemascope-width film. The film is stretched across a curved, polished surface inside the special one-ton cameras to yield 2 x 12-inch pictures of the satellite track.

Tracking satellites is only one of many uses for these photographic materials during the IGY, according to W. F. Swann, manager of Special Sensitized Products Sales, who is in close touch with scientists in the field.

Scientists studying the moon and sun will also have special film in their cameras. In many countries 16 x 16 centimeter Kodak Spectroscopic Plates will aid study of our ancient satellite, the moon.

Recently, when a balloon was sent into the dust-free upper atmosphere for photography of the sun, its telescope mounted camera contained Kodak Spectroscopic Film Type *5-G*. In addition to the high contrast and fine grain, the film has great sensitivity to yellow light—the color of burning calcium at the sun's surface.

Measurements of Steep-Front Impulse Waves

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THE MEASUREMENT of steep-front impulse waves presents problems seldom encountered in ordinary 1½ x 40 microsecond impulse wave testing. The problem consists of obtaining linearly rising steep-front voltage oscillograms which faithfully reproduced, to a known scale, the voltage wave as seen by the test specimen. Stray or residual divider parameters, as well as the methods used in grounding, shielding, supplying power, and synchronizing the oscilloscope, may introduce spurious responses into the voltage oscillograms.

Divider errors may be minimized by proper design of the high-side and low-side divider resistors and by correct termination of the transient cable at the oscillograph. Transient cable correction factors should also be determined to compensate for attenuation in short cable lengths. An isolated screen-room installation was designed and built to eliminate those spurious responses which may be introduced by the methods used to ground, supply power, shield, and synchronize the oscillograph.

The high-side divider resistor was patterned after the one described by W. H. Park and H. N. Cones. The low-side divider resistor consists of four parallel loops of resistance ribbon 1/16- by 0.001-inch thick arranged 90° apart around the axis of the resistor. Each loop is arranged to double back on itself with a single layer of 0.001-inch thick insulating tape between the sides of the loop. The assembly is arranged concentrically with respect to a standard coaxial terminal which is connected to the transient cable leading to the oscillograph. A shield is provided to reduce stray field pickup at the junction of the low-side and high-side resistors. The 1,000-ohm high-side resistor and the 1-ohm low-side resistor provide the necessary resistance ratio for proper oscillograph deflection.

The oscillograph is placed in a doubly shielded screen room to eliminate stray field pickup which may introduce unwanted signals into the sweep and blanking circuits of the oscillograph. The two shields of the screen room together with the chassis of the oscillograph form a series of three concentric Faraday cages within which are located the transient plates of the oscillograph. A triple shielded 100-foot transient cable is used to connect the oscillograph with the low-side divider resistor. The three shields of the transient cable are connected together and grounded at the low-side divider resistor only. In order to reduce ground currents that may flow in the outer sheath, no ground connection is made at the oscillograph. The screen room and transient cable are isolated from all surrounding grounds in the oscillograph room. A motor–generator set, with the generator located within the screen room and connected to the outside motor with an insulating shaft, is used to supply power to the oscillograph.

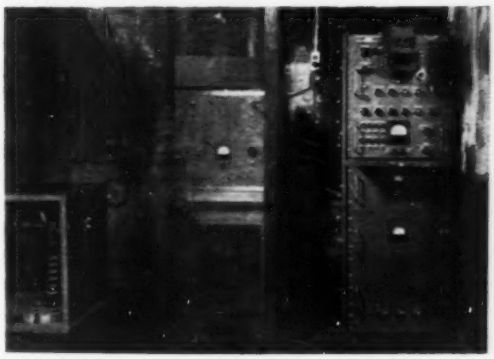

Fig. 1. Interior of isolated screen room showing oscilloscope and synchronizing pulse amplifier.

The synchronization of the oscillograph with the impulse generator, while maintaining the complete shielding and isolation of the oscillograph, is provided by a light-beam pulse produced by a trigger circuit which also fires the generator. An electron multiplier phototube located within the screen room converts the light pulse to an electric signal which is amplified and used to trip the sweep circuits of the oscillograph. The interior of the isolated screen room is shown in Fig. 1. The electron multiplier phototube and preamplifier cabinet with condensing lens is shown just to the right of the CRO synchronizing gap. The alternator is located directly below phototube cabinet.

A 12.5-cm sphere gap with 6-cm spacing was chosen as a specimen to demonstrate the effectiveness of the isolated screen room installation by comparing test results with the data obtained by Park and Cones for a similar specimen at the National Bureau of Standards. A linearly rising voltage wave was applied to the specimen gap with flashover occurring on the front of the wave. Crest voltage was plotted as a function of time to flashover and compared with the ±2% band obtained by Park and Cones. All points from 2.3 microseconds to 0.027 microseconds fell within this band. This indicates the effectiveness of the isolated screen-room installation. The correlation of steep-front data demonstrates the practicality of using the volt-time curve of a sphere gap as a reference standard for checking steep-front measurement circuits.

Digest of paper 58-18, "Measurements of Steep-Front Impulse Waves with an Isolated Screen Room Installation," recommended by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 2-7, 1958. Scheduled for publication in AIEE *Communication and Electronics*, 1958.

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A Reliability Handbook for Design Engineers

F. E. DRESTE

This article discusses a reliability handbook which has been specially prepared to aid guided missile electronics design engineers. The major section of the handbook explains methods for designing reliability into equipment by the adherence to certain "ground rules." Emphasis is placed on the use of statistical techniques.

SIGNIFICANT RESULTS were obtained a few years ago in the form of more reliable missile equipment through the vigorous pursuit of three basic "ground rules" for design reliability, as reported in studies made by Motorola, Inc.[1] Management realized that much the same effort would be valuable to some of the company's other projects, and so a central group was set up, reporting directly to the engineering manager, to help all projects in the design of more reliable equipment. As a portion of its effort, this reliability and components group issued copies of the "Reliability and Components Handbook" to each engineer for ready reference. The first copies were distributed in late 1955. Continual additions and revisions since then have kept these books up to date.

The handbook is divided into three sections, the first two of which are subordinate. Section 1—General and Philosophy—is an introduction to the reliability problem, and shows the design engineer the necessity for directed effort. Several significant papers are contained in this section.[2,3] Also included are references to other worthwhile reliability publications.

Section 2—Basic Reliability Mathematics—acquaints the design engineer with the basic fundamentals of reliability mathematics without going into many details. The intent is to get the design engineer to "speak the same language" as the reliability engineer by use of rule-of-thumb methods that will give "in the ball park" estimates. Both the well-known product rule and the exponential reliability equation are included, with examples, so that the designer can easily understand the reasons why reliability so often is very low. The point is stressed that only 35% reliability will be achieved for a time approximating the average life of most parts and equipments.

However, engineers frequently err in thinking that *high* reliability can be expected up to the average lifetime. This section shows them that 99% reliability can be expected for only 1% of the average life and 90% reliability for about 10% of the average life.

The third and most valuable section—Design for Reliability Ground Rules—stresses the fact that reliability must be designed into equipment from the beginning to achieve the highest order of final result. Specific techniques for effecting a reliable design from the beginning are given in this section.

Ground Rule 1: Use Recommended Parts and Tubes with Adequate Derating for Higher Reliability. The electrical parts and tubes for guided missiles are generally recommended and derated on the basis of their ability to perform reliably under conditions of

1. —65 C to 125 C ambient temperature range
2. Vibration of at least 20 g to 1,000 cps
3. Shock of at least 50 g for 10 milliseconds
4. High humidity.

These recommendations for parts and tubes, together with their parameter variations (discussed under Ground Rule 2) are based upon past experience and extensive testing by Motorola's reliability and components group. It may be of interest to review the objectives of this group as related to the foregoing recommendations. These objectives are:

1. To select the most reliable parts available in production quantities from more than one source and controlled by adequate drawings and specifications
2. To determine realistic deratings and parameter variations under operating conditions for high reliability of these parts
3. To advance the growth of parts reliability through close co-operation with parts manufacturers on feedback of test and failure information
4. To keep aware of new products being developed and evaluate them as quickly as possible.

An effort is made to understand more completely the performance of all units tested, by studying their behavior during test, by dissection, and by careful evaluation of materials and construction practices. In general, the desired characteristic is long-term, stable performance under the extreme environmental conditions. Confident component part evaluation is no easy matter and is achieved only over a period of years.

Ground Rule 2: Allow for Realistic Variations in Parts and Tubes and Use a Statistical Approach to Circuit Design. The handbook lists over-all variations to

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be expected in parameters of parts and tubes under operating conditions resulting from such causes as environments and aging, in addition to the parts manufacturing tolerances. Possessing this information, the engineer knows, when he begins his design, the over-all variability of the parts and tubes with which his circuits must operate. An example of this type of information is shown in Fig. 1.

Factors which contribute to the lowest values are the tube manufacturing tolerance, filament voltage 10% below nominal, aging, and tube stability.

Factors which contribute to the highest values are the tube manufacturing tolerance, filament voltage 10% above nominal, and tube stability. The plus and minus values are considered to be normally distributed about the value preceding them. Thus, the designer should design his circuit to operate properly with transconductance variations from 36% below nominal to 30% above nominal for the factors mentioned.

As is well known, the design problem for mass-produced equipment is much different from that for a single model, because of parts tolerances. The experimenter may tailor his model by selecting the optimum value for each part to provide the desired equipment performance, but mass-produced reliable equipment must give this performance using parts which have values varying throughout their tolerance ranges under conditions of use. Herewith, substantial excerpts from the "statistical approach" as explained in the handbook are presented.

For maximum producibility and reliability, the designer might try to design the equipment to perform properly with all parts simultaneously at their tolerance limits and in such a direction as to produce the greatest deviation in nominal performance. In many cases, it will be found that this attempt will fail because even the best and highest precision parts will not have sufficiently small tolerances. In other cases, the problem may be solved insofar as tolerance considerations are concerned, but at the expense of complicating the circuitry to the extent that its over-all reliability may be lower than that for an equipment of fewer parts which does not satisfy the aforementioned extreme tolerance build-up. Fortunately, the probability that all the parts will exist at their maximum tolerances simultaneously is very remote. Let us investigate the manner in which the individual parts tolerances affect the over-all tolerance. This effect of individual tolerance forms the basis for the statistical approach to circuit design.

It is well known that many production parts have a

PARAMETER	LOWEST VALUES	HIGHEST VALUES
TRANSCONDUCTANCE	-21 ±15%	+15 ±15%
PLATE CURRENT	-30 ±23%	+20 ±23%
AMP. FACTOR	-8 ±7%	+10 ±8%

Fig. 1. Over-all variations to be expected in tubes.

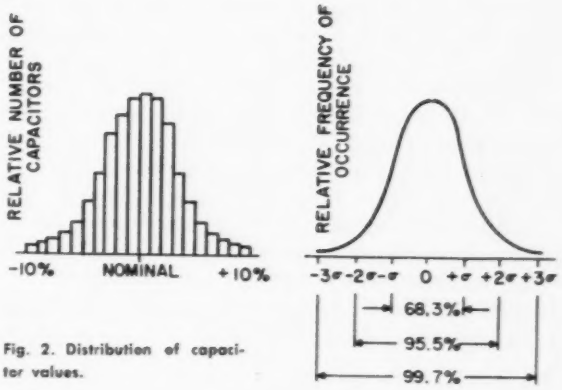


Fig. 2. Distribution of capacitor values.

normal or Gaussian frequency distribution as illustrated in the following example. Suppose that measurements were made of the values of a large quantity of capacitors of the same nominal value and ±10% tolerance. Plotting vertically, the number of capacitors in each 1% interval of capacitance will usually result in a histogram similar to the one shown in Fig. 2. As the quantity of capacitors measured is increased and the capacitance interval is narrowed, the envelope of the histogram will form a normal distribution curve as shown. This curve is symmetrical about the average and asymptotic at the base.

The total area under the curve represents all the capacitors. The area bounded by $\pm\sigma$ covers 68.3% of the total area; that is, 68.3% of the capacitors are included by $\pm\sigma$. About 95.5% of the capacitors are included by $\pm 2\sigma$ and 99.7% are included by $\pm 3\sigma$. The manufacturing tolerance will usually correspond to $\pm 3\sigma$ or greater, depending upon the degree of production control; that is, 0.3% or less of the parts usually will be out of tolerance. Of course, additional variations in capacitance will result when the capacitors are subjected to conditions of operation and environment.

Even when individual parts values are not normally distributed, their associated circuit output variations will be nearly normally distributed because of combination effects.

It is important that engineers design circuits that meet tolerance specifications in a very high percentage of the equipments built, both from production and reliability standpoints. To illustrate with an oversimplified example, consider a circuit which, in production, must meet a tolerance of 97 to 103 volts output (Fig. 3). If the design allows production to meet this specification to the 3-sigma limits of a typical normal distribution as shown in Fig. 3 (A), there are only 3 out of 1,000 circuits which require parts changes to meet the specification. In many instances, however, designs have allowed production to meet the specification only to the 1-sigma limits, as shown in Fig. 3 (B), whence over 100 times as many circuits (31.7%) require costly parts changes involving special selection to meet the specification. This results in a nearly rectangular distribution. With this distribution, there are, of course, many more

circuits near the specification limits than in the case of Fig. 3 (A). If severe environments and operating conditions allow only equipments using those circuits measuring between 98 and 102 volts on the production line to "hit the target," about 30% of the equipments using the circuits of Fig. 3 (B) would fail to do their job, compared to only 4% failing with the circuits of Fig. 3 (A). Thus, much higher reliability results in the latter case, even though the circuits met the specification in both cases. From this example, it is easy to see why we are striving for designs to meet at least the 3-sigma limits for their tolerances without rework, both from production and reliability standpoints.

Let us now see, with the aid of the following examples, how tolerances combine to meet the foregoing objectives.

Example 1: *Series Resistance Tolerance.* When parts values having a normal frequency distribution are combined, the resultant value will exhibit a tolerance advantage. If three such resistors (3,000 ohms, 2,000 ohms, and 1,000 ohms) each of $\pm 10\%$ tolerance are connected in series, the total resistance expected will be:

$$R_s = 6{,}000 \pm \sqrt{300^2 + 200^2 + 100^2} = 6{,}000 \pm 374 \text{ ohms} = 6{,}000 \pm 6.2\% \quad (1)$$

This will be the combined value with the same probability that each resistor range is $\pm 10\%$; that is, if the tolerance of each resistor is $\pm 10\%$ in 99.9% of the cases, the sum will be 6,000 $\pm$ 374 ohms in 99.9% of the cases. If more resistors are combined, the over-all tolerance improvement will be greater.

$$\text{Combined tolerance} = t_s = \sqrt{t_1^2 + t_2^2 + t_3^2 + \ldots t_n^2} \quad (2)$$

where t_1, t_2, etc., are the individual tolerances, each of which must contain the same number of sigmas. The resulting combined tolerance will also contain this same number of sigmas. That is, if

$$t_1 = A\sigma_1, t_2 = A\sigma_2, \text{ etc.}$$

then

$$t_{sum} = A\sigma_{sum} \quad (3)$$

Thus, it is seen that equation 2 is derived from the more basic equation

$$\sigma_s = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 + \ldots \sigma_n^2} \quad (4)$$

It is preferable, wherever possible, to express a result as a sum of values to utilize the mathematics of probability more easily. In many cases, this can be done by using the logarithms of values which are to be multiplied or divided and by using the reciprocal of values which combine in the same manner as parallel resistances.

Example 2: *7-Stage I-F Amplifier Gain Variations.* Let us check a 7-stage i-f amplifier for gain limits, where each stage uses the same tube type with a bogey transconductance of 5,000 micromhos and a 1-kilohm composition load resistor (very lightly loaded). The tube and resistor variations used are those given in the handbook wherein the $\pm$ values are the 3-sigma limits for normal distributions centered about the values preceding them.

For Lowest Expected Gain:

Tube Contribution:

(g_m low by 21% $\pm$ 15%)
$g_m = 5{,}000\ (0.79 \pm 0.15) = 3{,}950 \pm 750$
Gain per stage (nominal r_l) $= g_m r_l = 3.95 \pm 0.75 = 11.9 \pm 1.7$ db

Tube and Resistor Contribution:

r_l low by 8.5% $\pm$ 6.7% contributes a decrease of 0.77 db $\pm$ 0.64 db
Then gain per stage = 11.9 db $-$ 0.77 db $\pm$ 1.7 db $\pm$ 0.64 db
$= 11.13 \pm \sqrt{1.7^2 + 0.64^2}$ db
7-stage gain $= 7 \times 11.13 \pm \sqrt{7\ (1.7^2 + 0.64^2)}$ db $= 77.9 \pm 4.8$ db

For Highest Expected Gain:

Tube Contribution:

(g_m high by 15% $\pm$ 15%)
$g_m = 5{,}000\ (1.15 \pm 0.15) = 5{,}750 \pm 750$
Gain per stage (nominal r_l) $= g_m r_l = 5.75 \pm 0.75 = 15.2 \pm 1.1$ db

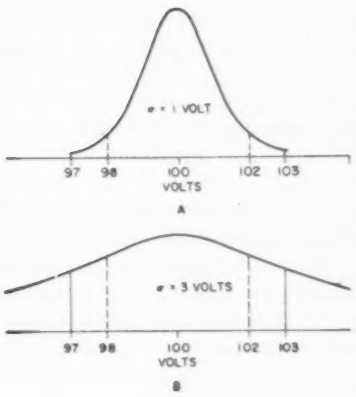
Tube and Resistor Contribution:

r_l high by 12% $\pm$ 5.4% contributes an increase of 1 db $\pm$ 0.4 db
Then gain per stage = 15.2 + 1 $\pm$ 1.1 $\pm$ 0.4 db = 16.2
$\pm \sqrt{1.1^2 \pm 0.4^2}$ db
7-stage gain $= 7 \times 16.2 \pm \sqrt{7\ (1.1^2 \pm 0.4^2)}$ db $= 113.4 \pm 3.1$ db

Therefore, the gain of this amplifier under typical production and operating conditions is expected to lie between 73.1 db and 116.5 db. During the past several years in which i-f strips have been in production at Motorola, this gain variation has been shown.

Through use of these principles, other more complex circuits have been successfully investigated to determine whether or not they had adequate safety margins to meet their required tolerances. This approach has been valuable not only in avoiding production of unreliable equipments, but also in avoiding the wasted breadboarding of circuits which are incapable of performing consistently within required limits.

Ground Rule 3: Thoroughly Test Equipment Models and Adequately Analyze Results for Corrective Action. Although good initial designs based upon the ground rules already discussed will greatly reduce the number of changes during development and production, they cannot remove the need for exhaustive equipment testing throughout an entire development program if high over-all reliability is to result. During this testing, careful attention must be given to failure causes for corrective action, and periodic failure rate graphs must be made to help produce a systematic increase in equipment reliability and to predict the reliability of later models. It is important that a specific engineer on each project be assigned to collect and analyze the failure data necessary for reliability improvement. Data on standard failure report forms are checked by this engineer to assure that sufficient information has been recorded before he submits the report and failed part to the reliability and components group for examination. The results of these examinations are fed back to the project as an important link in the reliability chain.



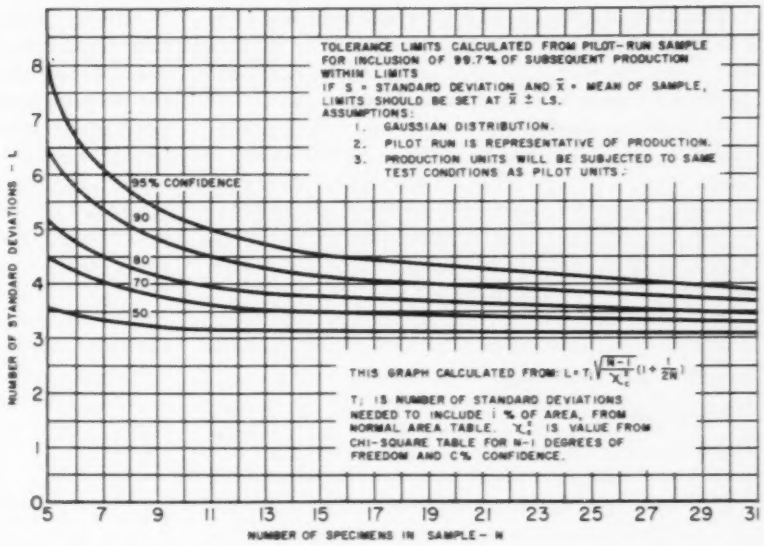

TOLERANCE LIMITS CALCULATED FROM PILOT-RUN SAMPLE FOR INCLUSION OF 99.7% OF SUBSEQUENT PRODUCTION WITHIN LIMITS.
IF S = STANDARD DEVIATION AND $\bar{X}$ = MEAN OF SAMPLE, LIMITS SHOULD BE SET AT $\bar{X} \pm LS$.
ASSUMPTIONS:
1. GAUSSIAN DISTRIBUTION.
2. PILOT RUN IS REPRESENTATIVE OF PRODUCTION.
3. PRODUCTION UNITS WILL BE SUBJECTED TO SAME TEST CONDITIONS AS PILOT UNITS.
95% CONFIDENCE
90
80
70
50
THIS GRAPH CALCULATED FROM: $L = T_i\sqrt{\frac{N-1}{\chi^2_c}\left(1+\frac{1}{2N}\right)}$
T_i IS NUMBER OF STANDARD DEVIATIONS NEEDED TO INCLUDE i % OF AREA, FROM NORMAL AREA TABLE. χ^2_c IS VALUE FROM CHI-SQUARE TABLE FOR N-1 DEGREES OF FREEDOM AND C% CONFIDENCE.
NUMBER OF STANDARD DEVIATIONS - L
NUMBER OF SPECIMENS IN SAMPLE - N
0 1 2 3 4 5 6 7 8
5 7 9 11 13 15 17 19 21 23 25 27 29 31

Fig. 3 (above). Voltage output distributions. Fig. 4 (right). Tolerance limits calculated from pilot-run sample.

Thorough equipment testing is necessary to determine the required run-in time to eliminate early failures, beyond which a lower, nearly constant failure rate continues until wear-out. The wear-out time should also be found, or at least determined to be well beyond the required mean life for the equipment.

As will be discussed in the following paragraphs from the handbook, statistical analysis of the measured variability of circuit outputs on equipment models can be used to determine more accurately whether or not the design is adequate to meet tolerance requirements in production consistently.

In order to predict most accurately circuit output tolerances which will be achieved under production conditions, it is necessary to utilize properly the measurements obtained on engineering models, prototypes, and pilot production units. For example, after a number of prototype power supplies have been built, it may be necessary to specify output voltage limits which will be used to accept or reject future production of these power supplies. Or, if the voltage limits are already dictated by functional considerations or customer specifications, it will be desirable to know something about how many rejects can be expected in production, assuming the same construction practices and parts are used as in the prototypes. In either case, the variability displayed by the prototypes can be used to predict the variability of subsequent production. It should be understood that the tolerances to be met in production must be tighter than those required in the end use of the equipments to allow for environmental, aging effects, and other factors previously discussed.

Of course, much earlier than the prototype phase (before and during the breadboard phase), the designer should have considered the output tolerance and made calculated estimates of how it is affected by individual tolerances of tubes and other component parts as explained under "Statistical Approach to Circuit Design." The designer should also have tried tubes, other critical parts, and supply voltages at their limit values early in the developmental phase. However, even though such thorough analyses are made during the design stage to reduce future problems to a minimum, increased accuracy of the estimates for the circuit tolerances which can be met in production can be gained through the statistical analysis of the variability of prototype equipments.

Let us now see how we can make the best use of measurements on prototypes to help set realistic production tolerances.

The problem may be phrased as follows: "Measurements of a particular parameter such as a circuit output voltage, have been made on a prototype run of a few (say seven) units. We therefore have a mean ($\bar{x}$) and a standard deviation (s) which describe the distribution of the measurements. It is desired to set high and low limits such that a high percentage of a large production quantity will be included within the limits. Yet the limits cannot be unnecessarily wide. After the limits are chosen, they will be investigated to see if they are satisfactory from a functional point of view. We must assume that the prototype sample is representative of the production which will follow, that the parameter being measured is distributed normally, and that production units will be subjected to the same test conditions as the prototype units.

A very simple but rough approach to the problem is merely to allow three standard deviations below and above the mean. For a normal distribution where m and σ (the equivalent of $\bar{x}$ and s, but here being constants for the entire universe) are known, this procedure would include 99.7% of the production within limits. However, the problem is complicated by the fact that $\bar{x}$ and s are only approximations of m and σ, being very poor approximations when n, the number of specimens in the prototype sample, is small.

There is a temptation to apply crude approximations and increase the tolerance to $\bar{x} \pm 4s$ or $\bar{x} \pm 5s$. However, since the mathematics of probabilities is a highly developed science, it is possible to be more exact.

By applying standard errors to $\bar{x}$ and s, it is possible to determine limits of each of these which would include m and σ to a given probability in future samples of n specimens. An approximate method of combining the uncertainties in $\bar{x}$ and s permits calculation of tolerance limits to any desired degree of confidence. However, this method is not as rigorous as some others.

A method derived by Hald[4] applies directly to our problem. It is fairly rigorous and results in the determination of L in the equation:

$$\text{Limits} = \bar{x} \pm Ls$$

Hald gives a table of values of L for several degrees of confidence and for several inclusion percentages. If, for example, we find L for 95% confidence and 98% inclusion, we mean that we are betting that our limits, $\bar{x} \pm Ls$, will include 98% of production, and that if this method is used over and over again, we will have been right 95% of the time. Hald's table was checked against his derived formula and values of L were calculated for additional degrees of inclusion. The portion of the data which appears most useful to us has been drawn as the graph of Fig. 4. All the curves were drawn for 99.7% inclusion which is a common production goal.

The application of Hald's method will now be applied to a typical set of measurements of a circuit output voltage.

Measurements obtained on seven preliminary units were 17, 18, 19, 16, 18, 18, and 19. From this we obtain $\bar{x} = 17.86$ and $s = 1.07$. From the graph, we find on the 90% confidence curve a value $L = 5.31$. Therefore, tolerance limits of $\bar{x} \pm 5.31s$ or 17.86 ± 5.68 will include 99.7% of production, and we may have 90% confidence in the truth of this statement.

It is readily seen from the curves that a large sample size with the same standard deviation will, of course, give equal confidence of a smaller variation to be expected in production.

Estimated production tolerances calculated by this method have given good correlation with subsequent missile equipment production at Motorola.

CONCLUSIONS

THERE ARE CERTAINLY many areas other than electronics design where special effort is important to achieve high reliability, such as mechanical design, manufacturing, quality control, and purchasing. However, the electronics design area usually requires the most effort to achieve high-reliability guided missile electronic equipments. To guide this effort, this handbook has been provided to every engineer for ready reference to put into action the three ground rules discussed. Each of these rules demands strict attention if high reliability is to be achieved.

Although insufficient time was spent discussing some very important details of these ground rules, it was deemed more important to emphasize the statistical tools the designer needs, which have not been given enough emphasis in reliability publications. Although the statistical methods discussed have limitations, they are surely much better than the guesswork and intuitive methods so often used by electronics designers to estimate circuit variability. The handbook material is relatively easy for the electronics designer to understand and put to use, whereas most published material is understood only by the mathematician specializing in statistics. When each design engineer uses statistical approaches to circuit design and to test data evaluation, an important step toward higher reliability will have been taken.

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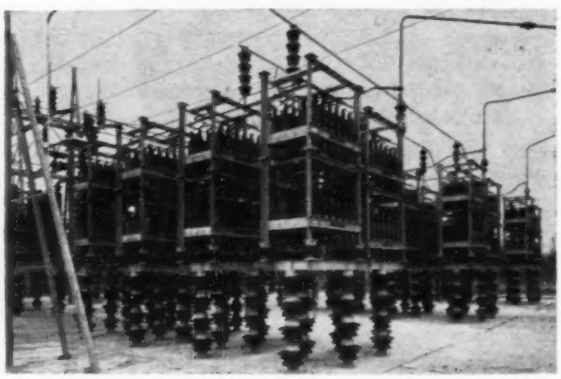
Series Capacitor Bank



One of the world's largest high-voltage series capacitor installations has been energized on the lines of the Louisiana Power & Light Company. Rated 57,600 kvar, 115/161 kv, 60 cycles, 600 amperes, 3-phase, the series capacitor application enables the utility to push large blocks of power economically from southern to northern Louisiana over a new transmission line which parallels a smaller existing line.

The capacitors, supplied by the General Electric Company, reduce inductive reactance for the new, larger conductor. As a result, upon energization the circuit load was increased from 60,000 to 90,000 kw.

The Accurate Determination of Capacitance

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THE PRINCIPAL OBJECTIVE of the work described in this paper is as follows: to develop a new method for accurately determining the capacitance associated with two-dimensional composite regions. The term capacitance refers to the ordinary electric capacitance associated with two charged conductors. However, the method is also directly applicable to the determination of the permeance of magnetic fields, the shape factor of thermal fields and to other analogous situations. "Accurately determine" is taken to mean determination of the capacitance with errors in the order of one part in one thousand. Although such accuracy has been claimed for certain electrolytic tank analog methods, it is usually possible only after careful attention is given to each source of error. Such errors can arise in both the construction and the measurements associated with the analog solution. In the present method, electrically conducting paper models, much easier to construct, are used and only ordinary care is required in the measurement techniques. The usual errors encountered in the use of such paper models, amounting to several per cent, are avoided by utilizing analytical methods to obtain a first approximation amounting to perhaps 90% of the final result, and using the paper analogs to determine the other 10%. Thus, the error in the final result will be in the order of a few per cents, of say 10%, or in the order of a few tenths of 1%.

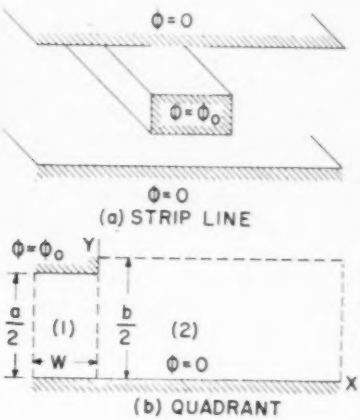

Fig. 1. Double-ground-plane strip transmission line.

"Two-dimensional region" refers to a region of electric field in the vicinity of two cylindrical (not necessarily circular) conductors, or, in other words, a region in which the electric field is independent of one of the co-ordinate variables. A composite region is one which can be divided by means of thin insulating or conducting partitions into two or more simple regions. A simple region is one in which the electrical potential function can be determined exactly by some known analytical method for example, by use of the Schwarz-Christoffel transformation.

A typical example of a composite region is that associated with the strip transmission line of Fig. 1. To determine the capacitance per unit length for this configuration, a first approximation is made analytically by imagining a thin insulating partition to divide the quadrant into two simple regions. For each of the regions marked (1) and (2) an analytical expression for the capacitance can be worked out, in the latter case using the Schwarz-Christoffel transformations. The first approximation to capacitance is simply the sum of the capacitances so determined.

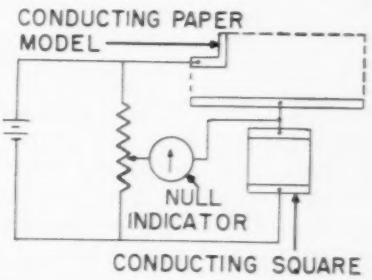

Fig. 2. Conventional analog method for capacitance determination.

To determine the additional capacitance which must be added to this first approximation to yield an accurate value, an electrically conducting paper analog is constructed. This analog corresponds to the fields which must be superimposed on the fields corresponding to the first approximation (with the insulating partition in place) in order that the boundary conditions of the original composite region are completely satisfied. In particular, it compensates for the presence of the partitions by assuring continuity of potential and normal flux density at the partition. A schematic of the analog is shown in Fig. 2. A simple measurement of current in the model and current in a calibrating square of the conducting paper yields the desired increment in capacitance. Results of this problem show a maximum error of 0.35% of fringe capacitance.

The method described combines analysis and analog techniques to take full advantage of the accuracy of the former and the simplicity of the latter

Digest of paper 58-65, "Accurate Determination of Capacitance by Conjoining Analytical and Analog Techniques," recommended by the AIEE Basic Sciences Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 2-7, 1958. Scheduled for publication in AIEE *Communication and Electronics*, 1958.

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Class III - V Compound Rectifiers

G. B. KICH

Although it is theoretically possible to make rectifiers out of nine IIIB-VA compounds, the three compounds, InP, GaAs, and AlSb are the most promising. These three compounds offer fabrication difficulties but their challenge has already been met with practical techniques.

COMMERCIAL RECTIFIERS of almost all types are presently fabricated from the familiar elemental semiconductors, selenium, geranium, and silicon. Special types of rectifiers have also been made over the last 50 years from compound semiconductors such as copper oxide, silicon carbide, and lead sulphide. However, it was not until Welker showed in 1952 that aluminum antimonide and indium antimonide were semiconductors, that all the binary compounds from the elements of the third and fifth columns of the periodic table came under consideration as semiconductor material for rectifiers.

PHYSICAL AND CHEMICAL PROPERTIES

THE FOLLOWING are some of the semiconductor physical and chemical properties that are of interest to rectifier designers: the energy gap, the mobility of the current carriers, the doping impurity ionization energy, the dielectric constant, the melting point, the thermal conductivity, the minority current carrier lifetime, and the chemical stability of the compound.

1. The energy gap determines the intrinsic resistivity of the pure compound, and therefore the saturation current density in the reverse biased rectifier, as well as its maximum operating temperature. The threshold voltage of the forward biased rectifier is also a function of the energy gap.
2. The forward current density and the frequency response of the rectifier depend on the current carrier mobility and the minority carrier lifetime in the semiconductor compound.
3. The doping impurity ionization energy and the dielectric constant affect the variation of conductivity with temperature of the intrinsic semiconductor and, hence, of the rectifier.
4. The thermal conductivity governs the dissipation of heat from the semiconductor and so influences the level of current operation of the rectifier.
5. Some rectifier fabrication problems can be related to the melting point of the semiconductor, while its chemical stability may determine the useful life of the device.

The energy gap, the melting point, the mobility of the current carrier, and the dielectric constant of the semiconductor can all be related to the type of "chemical bond" between the atoms. Ionic bonding favors a higher energy gap than covalent bonding. The stronger ionic bond also favors a higher melting point. The polarizable covalent bond yields a larger dielectric constant. Scattering of the current carriers by interaction with the ionized atoms of the ionic bonded lattice will give a lower mobility of the carriers than would a covalent bonding.

The cubic type of diamond lattice possesses essentially covalent bonding. The semiconducting elements carbon, silicon, germanium, and alpha-tin of the IVA column of the periodic table crystallize with this lattice. Fig. 1 shows for these elements some literature values for the energy gap, melting point, mobility, and dielectric constant. Here the decrease in energy gap and melting point with increasing atomic weight reflects the decrease in the strength of the covalent bonds as the electron screen becomes larger. For the same reason, polarizability increases with atomic weight, so the dielectric constant also becomes larger.

The zinc-blende, or substituted diamond lattice, is composed of at least two different kinds of atoms instead of all the same kind of atom as in the diamond type lattice. Because the electronegativity, or electron affinities, of the two different kinds of atoms is not the same, the almost completely covalent bonding in the diamond type cubic lattice is modified in the zinc-blende lattice by some degree of ionic bonding. This ionic component of the bonding should favor increased energy gap and melting point. Although a component of ionic bonding is introduced into this type of lattice, there is a reduction of the apparent charge on the ions brought about through the electronegativity difference between the two kinds of atoms. Therefore, even although ionic bonding tends to decrease current carrier mobility through scattering by the charged ions, the effect may be lessened with the proper electronegativity difference between the two kinds of ions. Also, in favor of increased current carrier mobility is the decrease in the thermal lattice scattering of the current carriers because of the ionic bonding contribution strengthening the covalent lattice bonding. As a result of these effects, it is possible to find high current carrier mobility and high energy gap in the same semiconductor. The reduction in apparent charge of the ions brought

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about by the electronegativity difference between the two kinds of atoms would also favor the retention of a higher dielectric constant.

Most of the compounds synthesized from elements of the IIIB and VA columns of the periodic table have the zinc-blende lattice structure. Figs. 2 and 3 exhibit values of certain physical properties of these compounds taken from the literature. The correlation of these properties with atomic weight pointed out in connection with Fig. 1, is also observed in Figs. 2 and 3.

Fig. 2 shows the energy gap and melting points of IIIB–VA compounds with the zinc-blende (substituted diamond) type lattice. All the phosphides and arsenides are unstable at their melting points and are best synthesized in closed systems. The compounds gallium antimonide (GaSb), indium arsenide (InAs) and indium antimonide (InSb) have energy gaps less than the 0.76 electron volts (ev) of germanium. Consequently, rectifiers made from these three compounds would be expected to have higher values of saturation current under reverse bias than similar germanium devices. Also, the temperature limitations of such rectifiers would be much more severe than the 80 C met with in germanium. Aluminum phosphide (AlP), aluminum arsenide AlAs), and gallium phosphide (GaP) have quite high energy gaps which indicate forward threshold voltages in rectifiers made from them will be more than twice the 0.5-volt value found in the 1.1-ev energy gap silicon devices. The melting points of AlP, AlAs, and GaP are all higher than the 1,420 C melting point of silicon, indicating additional device fabrication problems. The compounds aluminum antimonide (AlSb), gallium arsenide (GaAs), and indium phosphide (InP) all possess melting points between those of silicon and germanium, while their energy gaps are all higher than that of silicon. Thus, these latter three compounds should make rectifiers that will operate at temperatures in excess of the theoretical 300 C silicon device operating temperature.

Fig. 3 compiles the data in the literature on the mobility of the charge carriers in the IIIB–VA compounds. It is obvious that all nine compounds have mobilities that would be acceptable in rectifiers.

These compounds also have reasonable dielectric constants; for example, in GaAs it is 11, in GaSb 14, and in InSb 17. The data on ionization potentials of the doping impurity atoms in these compounds is incomplete, but in heavily doped samples of InP and GaAs activation energies for doping impurities are found to be in the hundredths of an electron volt as in silicon.

POTENTIALITIES OF COMPOUNDS

From the aforementioned compilation of physical properties of these nine IIIB–VA compounds, likely candidates for the rectifiers of the future can be deduced.

The three compounds AlP, AlAs, and GaP have not been investigated very thoroughly. The fact that they are unstable at their higher-than-silicon melting points and in the case of the first two compounds at room

		C	Si	Ge	α-Sn
ATOMIC WEIGHT		12.	28.	73.	119.
ENERGY GAP (EV)		~7.	1.12	0.76	0.06
MELTING POINT (°C)		3550	1420	936	?
DIELECTRIC CONSTANT		5.7	12.	16.	
MOBILITY $\left(\frac{CM^2}{VOLT\text{-}SEC}\right)$	ELECTRON	≲700	2,000	3,600	≥ 3,000
	HOLE	≲700	500	1,700	?

Fig. 1. Physical properties of the group IVA elemental semiconductors.

	P	As	Sb
Al	3. E.V. —	2.2 E.V. —	1.6 E.V. 1080°C
Ga	2.2 E.V. —	1.35 E.V. 1240°C	0.7 E.V. 720°C
In	1.25 E.V. 1070°C	0.33 E.V. 936°C	0.16 E.V. 523°C

Fig. 2. Energy gap and melting point of IIIB–VA compounds.

	P	As	Sb
Al	3,400 —	— —	1,200 300
Ga	— —	4,000 200	4000 700
In	3,400 650	30,000 100	70,000 500

Fig. 3. Current carrier mobility of IIIB-VA compounds. Top number is electron mobility; bottom number is hole mobility; units are CM^2/volt-second.

temperature as well, indicates considerable device fabrication difficulty.

On the other hand, however, single crystals of GaSb and InSb can be obtained by the conventional pulling technique used with silicon and germanium. InAs is unstable at the melting point, and special precautions must be taken to prevent the evolution of arsenic. All three compounds are very stable under room conditions. The energy gaps of InAs and InSb are too low for these compounds to qualify for practical general rectifiers. GaSb approximates germanium as a rectifier, although the fact that p-type samples with 10^{17} current carriers per cubic centimeter are the purest available prevents realization of this potential. The compound GaSb can be zoned-refined, and single crystals as well as grown junctions can be pulled from the melt. Zinc, cadmium, and copper are acceptor type impurities, and it seems as if antimony vacancies in the lattice also act as acceptors. Selenium and tellurium are donor impurities.

The remaining three IIIB–VA compounds, InP, GaAs, and AlSb all have energy gaps larger than silicon, which indicate they will be suitable materials for rectifiers to operate at higher ambient temperatures than possible with silicon rectifiers. Their higher energy gaps also point to lower reverse bias saturation currents than the 10^{-8} ampere of silicon devices. The forward bias threshold voltages should be only a few tenths of a volt higher than that of silicon rectifiers. The current carrier mobilities in AlSb approximate those in silicon, while in InP and GaAs, the mobilities are comparable to those in germanium. These compounds, then incorporate the better features of both germanium and silicon, and can qualify as rectifier materials of the future. All three of these compounds have exhibited point contact rectification which is comparable to germanium crystal diode rectification. One company published accounts in the summer of 1957 of substantial quantities of GaAs point contact diodes made in their laboratories. These units will operate efficiently over a broad frequency range at 450 C and can match the high frequency performance of germanium. These compounds, InP, GaAs, and AlSb, with their high energy gaps, exhibit the trapping and recombination effects seen in silicon. AlSb unfortunately is attacked by atmospheric water vapor at room temperature and decomposes on standing. InP and GaAs, however, are quite stable under room conditions. All three of these compounds are synthesized from the pure elements at temperatures above the melting points of the compounds. The reactions are carried out in sealed containers to prevent the evolution of the VA column element. Single crystals can be grown in sealed quartz containers, using a magnetically coupled pulling mechanism. The instability of these compounds at the melting point makes the fabrication of grown p-n junctions difficult, but solid-state diffusion techniques should be applicable.

It is to be noted also that, similar to the complete solubility of silicon and germanium in all proportions in each other, certain of the IIIB-VA compounds also are wholly miscible in each other. It has been demonstrated that, by varying the proportions of germanium and silicon, an alloy of any desired energy gap between the 0.76 ev of germanium and the 1.12 ev of silicon can be made. InAs and InP form such a system, and thus alloys can be made with any energy gap between 0.33 and 1.28 ev. Similarly, using the completely miscible compound GaAs and GaP, the range of energy gaps from 1.4 to 2.2 ev can be covered. A patent has been granted on an alloy of AlSb and GaSb which, it is claimed, resists oxidation or deterioration in humid atmosphere better than AlSb alone. The alloy is also said to have a higher band gap than silicon, and lends itself to device fabrication more easily than do silicon or germanium.

Although one of these IIIB–VA compounds, GaAs, is already being actively exploited as a point contact rectifier in the high frequency microwave range, in general, there is considerable work still to be done on these compounds before their potentialities can be fully realized. In 1954, the literature covered work done on these materials containing impurity derived current carriers of the order of 10^{18} atoms per cm^3. The results reported in the 1956 literature were on samples with impurity levels of 10^{17} atoms per cm^3, although InSb at least seemed to have been obtained with two orders of magnitude less impurities.

Summarizing, it may be said that it is theoretically possible to make rectifiers out of all of the nine IIIB–VA compounds discussed here; but practically the three compounds, InP, GaAs, and AlSb are the promising candidates for the rectifier materials of the future. These three compounds offer fabrication difficulties, but they are not insurmountable, and their challenge has already been met with practical techniques. The promise of the inherently better electrical characteristics and higher ambient temperature operating range of these compounds is, in fact, already being seriously tested in the case of GaAs.

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An Electroluminescent Digital Indicator

E. A. SACK
ASSOCIATE MEMBER AIEE

IN RECENT YEARS, there has been a strong trend toward the presentation of information to the human observer by means of digital rather than analog instrumentation. The significance of this trend is evidenced by the availability of a growing selection of alphanumeric display devices such as digital voltmeters and counters.

An electroluminescent digital indicator has been developed which provides a very desirable means for visual presentation of numerical information in digital form. Another electroluminescent device, the ELPAK (Electroluminescent-Photoconductive) relay, has been used to effect the translation necessary to excite this indicator.

In its most familiar form, a plastic embedded electroluminescent cell is a parallel-plate capacitor with a transparent conducting layer as the front electrode, a phosphor-plastic layer as the dielectric and an aluminum film as the back electrode. In the electroluminescent digital indicator, a set of seven back electrodes or segments are formed on the electroluminescent panel in a figure "8" pattern. With this arrangement, any numeral from 0 through 9 may be formed by applying excitation to the proper combinations of segments.

An electroluminescent digital indicator for a three-digit counter is shown in Fig. 1. A resin laminate sheet is glued to the back of the electroluminescent panel. A printed circuit pattern on this sheet carries the excitation from a standard printed circuit base to the 21 segments on the display.

With present Westinghouse electroluminescent panels, adequate brightness for a wide variety of ambient lighting conditions can be achieved with from 100 to 150 volts rms, 5 to 10 kc. Under typical operating conditions, the maximum power required by each numeral in the indicator of Fig. 1 is only 66 milliwatts. Excitation for a number of numerals can be supplied by a small transistor converter.

The signal information for a digital indicator may be in decimal form or, as is more often the case, it may be in a nondecimal code. In order that the input signal result in the excitation of the proper combinations of segments to form the associated numeral, some means of translation is required. Vacuum tubes, semiconductor devices, saturable cores, and ferroresonant circuits are all available to perform the switching operations required in the translation. However, electroluminescence itself can be used quite advantageously for this purpose.

If an electroluminescent cell is positioned to illuminate a photoconductor, there results a switching device, called an ELPAK relay. So long as no power is applied to the electroluminescent phosphor, the photoconductor is dark and has a high resistance between its terminals. When power is applied to the electroluminescent "emitter," however, the illuminated photoconductive "receptor" assumes a resistance which may be five orders of magnitude below its dark state.

An ELPAK NOR element circuit has been built to translate from a decimal input to the seven segment code of the electroluminescent digital indicator. When an input signal is received on one of ten input busses, the electroluminescent emitters illuminate the proper photoconductive receptors which, in turn, remove

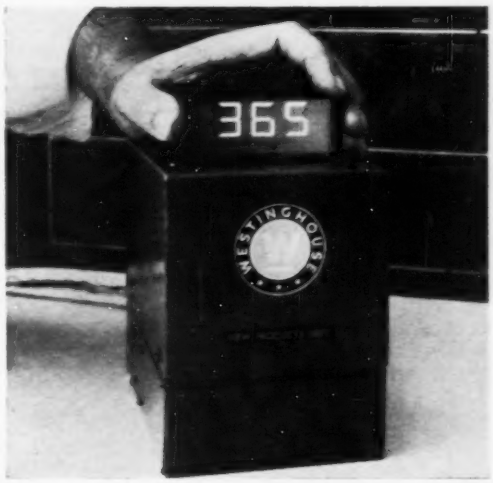


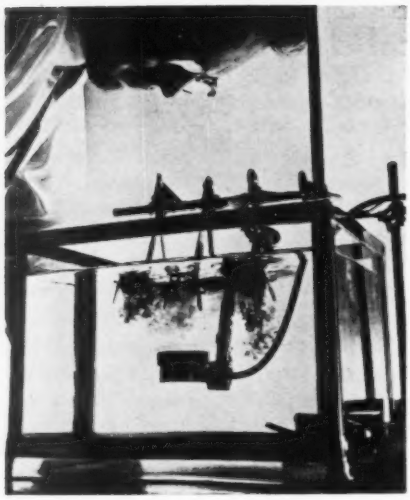
Fig. 1. A three-digit indicator in a counter.

power from the certain indicator segments. The remaining segments form the desired numeral. The life and reliability of this type of translation circuit are potentially very good. The speed of response is adequate for the application.

The electroluminescent digital indicator provides a numerical display with low parallax, high brightness, excellent readability, low power requirements, variable color, and wide dimensional flexibility. The logic and control which are required to translate information from a particular source to the seven segment code may make use of a wide selection of conventional devices. However, the ELPAK logic circuit which was built has proved to be very satisfactory.

Digest of paper 58-150, "An Electroluminescent Digital Indicator with ELPAK Translation Logic," recommended by the AIEE Solid-State Devices Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 2-7, 1958. Scheduled for publication in AIEE *Communication and Electronics*, 1958.

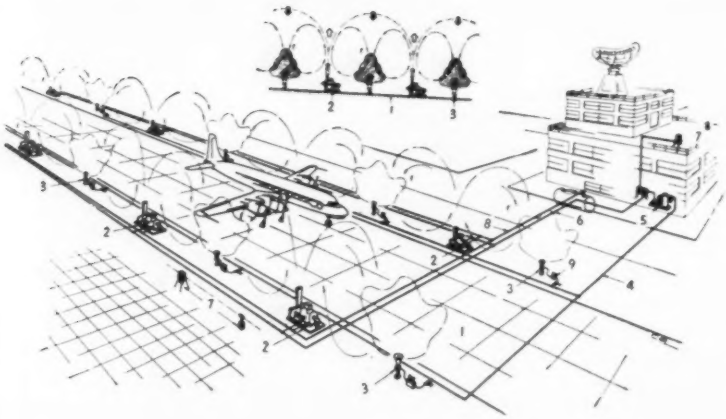
E. A. Sack is with the Westinghouse Research Laboratories, Pittsburgh 35, Pa.



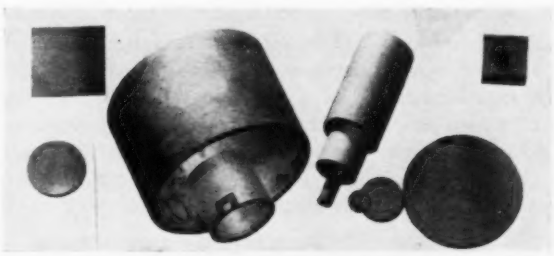
Pictorial Review

ULTRASONICS

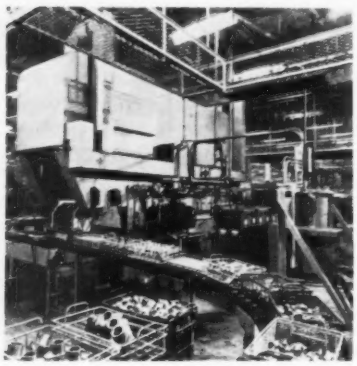
A NEW SCIENCE of high-frequency sound was born with the development of the first dog whistle in 1883. However, more than 50 years elapsed before scientists were capable of translating the science of ultrasound, propagation of sound waves in solids, liquids, or gases above audible range, into practical and commercial uses for mankind. Applications of ultrasonic equipment and instruments are seen in the picture *(upper left)* where soil literally explodes off optical lenses which require delicate handling. Nurse in photo *(upper right)* drops medical instrument into console ultrasonic cleaner designed for either hospital or private office use. Soil is dislodged by cavitation—the hammering action of the collapsing gas bubbles in the solution. The multiwhistle fog dispersal system used at airports is seen in the diagram. Successfully used in Europe, it shows: (1) runway, (2) atomizers including burners and sprays, (3) multiwhistles,



(4) compressed-air leads, (5) compressors, (6) electric leads, (7) visibility measuring unit, (8) fuel conduits, and (9) filter and air pressure regulator. Synthetic crystals used to produce vibrations are made in many shapes. Degreasing and cleaning of machine parts is accomplished by automated ultrasonic system *(lower left)*. Aluminum strip is soldered to stainless steel disc with ultrasonic soldering iron *(lower right)*. Discovery of piezoelectric ceramics launched the new industry.



Courtesy Gulton Industries, Inc.



Piezoelectric ceramics are considered superior to natural piezoelectric materials because they can be formed to any desired configuration and require lower and safer driving voltages, allowing intense focusing and concentration of energy into complex cavities hitherto impossible to irradiate. They allow higher frequency operation (500 kc) than most natural substances and the ceramic transducers, components that produce ultrasonic vibrations, can be polarized in any direction.

INSTITUTE ACTIVITIES

Buffalo Welcomes
1958 AIEE Summer General Meeting

BUFFALO, Birthplace of Electrical Power, will be the scene of this year's Summer General Meeting of the Institute, June 23-27. Headquarters will be at the Statler Hilton Hotel, located in downtown Buffalo, N. Y.

Hospitality

On Sunday, June 22, from 4 p.m. to 6 p.m., a Welcome Tea will be held in the New York Room on the mezzanine floor of the Statler Hilton Hotel. This will give everyone an opportunity to meet old friends and make new acquaintances before the business of the meeting starts. A Ladies' Hospitality Suite will be open throughout the week, providing an opportunity for the ladies to become acquainted with the features provided for them. Here, again, will be found an excellent opportunity for the ladies to meet with friends and make new acquaintances.

General Program

Registration, ticket, and preprints sale will begin on June 22 at 1:00 p.m. on the mezzanine floor. Technical sessions are planned from Monday to Friday, and cover, as may be seen from the list which follows, a variety of subjects. The opening ceremony will be held at 2:00 p.m. on Monday in the ballroom, officially welcoming members attending. The Annual Meeting will be held at 2:30 p.m., after the opening ceremony. On Tuesday, June 24, will be held a Section Delegates' Conference at 9:00 a. m. and again at 2:00 p.m.

On Wednesday, June 25, one of the highlights of the social events will be the Niagara Panorama trip, an all-day trip from 9:00 a.m. to 5:00 p.m. to which the ladies are invited. Bus transportation will carry visitors across the Peace Bridge to Canada and a luncheon will be provided at the Park Hotel in Niagara Falls, Ont. This promises to be a well-attended and interesting trip.

One of the highlights of the Thursday, June 26, program will be a noon-day luncheon in the Terrace Room which will be addressed by General M. C. Demler, deputy commander for research and development, Air Research and Development Command of the United States Air Force. This luncheon is particularly recommended for Air Transportation Conferees.

Technical Sessions

The tentative program of technical sessions follows. (Titles of papers will be published later.)

Monday, June 23

9:00 a.m. Morning Sessions
Radio Communication Systems
Power Generation
Substations
Semiconductor-Metallic Rectifiers
Transmission and Distribution

2:00 p.m. Annual Meeting

Tuesday, June 24

9:00 a.m. Morning Sessions
Radio Communication Systems
Land Transportation
Industrial Control
Power Generation and System Engineering
Magnetic Amplifiers
Section Delegates

2:00 p.m. Afternoon Sessions
Land Transportation
Industrial Power Systems
Special Instruments and Auxiliary Apparatus
System Engineering
Rotating Machinery
Magnetic Amplifiers
Computing Devices
Section Delegates

7:30 p.m. Symposium on Space Flight Control

Wednesday, June 25

9:00 a.m. Morning Sessions
Television and Aural Broadcasting
Air Transportation I
Industrial Power Systems
Indicating and Integrating Instruments
System Engineering
Rotating Machinery
Basic Sciences
Air Transportation II

2:00 p.m. Afternoon Sessions
Television and Aural Broadcasting
Air Transportation III
Mining and Metal Industry
Transmission and Distribution
Transformers
Computing Devices
Basic Sciences
Aircraft and Flight Test Instrumentation
Air Transportation IV

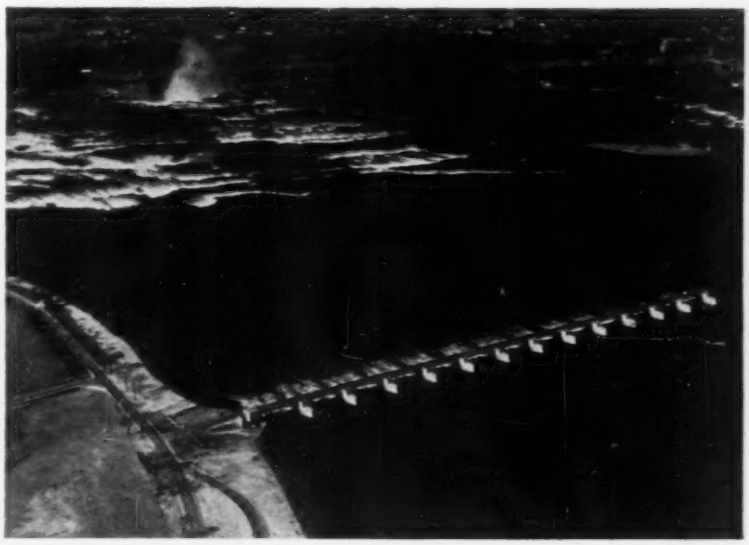
Thursday, June 26

9:00 a.m. Morning Sessions
Wire Communication Systems
Air Transportation V
Transmission and Distribution
Transformers
Dielectrics
Computing Devices
Basic Sciences
Telemetering

2:00 p.m. Afternoon Sessions
Communication Switching Systems
Air Transportation VI
Feedback Control Systems
Transmission and Distribution
Transformers
Dielectrics
Solid State Devices

Friday, June 27

9:00 a.m. Morning Sessions
Communication Theory
Air Transportation VII
Air Transportation VIII
Feedback Control Systems
Insulated Conductors
Switchgear



Ontario Hydro Photo

COMPLETION of the far-reaching remedial works program to preserve and enhance the beauty of Niagara Falls was marked by dedication ceremonies during 1957. This picture shows the Grass Island Pool control structure, which extends 1,550 feet from the Canadian side of the river, about a mile above the Falls. Each of the 13 gates in this structure is 100 feet wide and weighs approximately 150 tons. The gates are operated by means of a hydraulic system. Purpose of the structure is to control the water level in the Chippawa–Grass Island Pool area. An all-day Niagara Panorama Trip will be one of the highlights of the AIEE Summer General Meeting.

2:00 p.m. Afternoon Sessions
Air Transportation IX
Air Transportation X
Feedback Control Systems
Insulated Conductors
Relays and Transformers
Electronic and High Frequency Instruments

President's Reception

Thursday, June 26, features one of the most important events of the meeting. The President's Reception and Banquet will be held in the Ballroom foyer starting at 6:30 p.m., with the Banquet held in the Ballroom at 7:30 p.m. The Honorable D. A. Quarles, Undersecretary of Defense, will be present and the highlight will be the presentation of an Honorary Membership in the AIEE to Dr. Quarles by W. J. Barrett, president of AIEE. This will be an informal affair, followed by a period for dancing.

Inspection Trips

A program of 12 inspection trips has been arranged to permit delegates to become familiar with engineering work being done in the Niagara Frontier Area, which includes Canada.

Two trips to a large Bethlehem Steel Plant in Lackawanna, N. Y., have been planned—one for Monday, June 23, and one for Thursday, June 26.

On Tuesday, June 24, an all-day inspection trip, from 9:00 a.m. until 5:00 p.m., will be made via bus transportation to the Lapp Insulator Plant in LeRoy, N. Y.

On this same day, an inspection trip to the Westinghouse Electric Corporation Motor and Control Division Plant, in Cheektowaga, N. Y., has been planned from 9:00 a.m. until noon.

An extraordinary opportunity will be provided on Tuesday, June 24, to attend an inspection trip to the Nike Base on Grand Island, N. Y., for a limited number of delegates.

On the afternoon of June 24, an inspection trip will be made to Ford Motor Company Stamping Plant in Hamburg, N. Y.

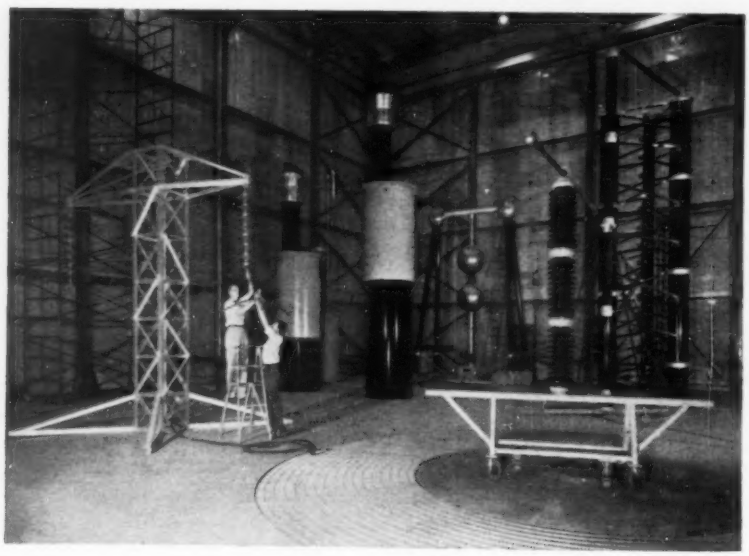
On Wednesday, June 25, inspection trips are planned to the New York Telephone Company from 9:00 until noon, and the Bell Aircraft Corporation from 2:00 p.m. until 5:00 p.m. This trip to Bell Aircraft will provide some interesting surprises.

Also on Wednesday, June 25, at 2:00 p.m. there will be an inspection trip to the Huntley Steam Generating Station of the Niagara Mohawk Power Corporation. This will provide an opportunity to visit one of the largest steam electric stations in the United States.

On Thursday, June 26, an inspection trip is planned to the Cornell Aeronautical Laboratory in Cheektowaga, N. Y. It is at this laboratory that much original work is done, solving problems relative to missile development. This trip will be from 9:00 a.m. until noon.

An all day trip, covering a visit to the Sir Adam Beck Generating Station in Canada and including the new Lewiston Power Project of the New York State Power Authority, will end with a visit to the Edward Dean Adams Station, which provided the first alternating current for system distribution in the United States. This trip, from 9:00 a.m. until 5:00 p.m., will include a talk by R. R. Macleod of the Niagara Mohawk Power Corporation, covering the theme of the Summer Meeting—"The Birthplace of Electrical Power."

Also, on Thursday, June 26, an inspection trip of the Chevrolet Motor Division of General Motors Corporation, in Buffalo, will be held from 9:00 a.m. until noon.



INTERIOR of the John Lapp High Voltage Laboratory looking from the control room. Some of the test equipment is visible, including the three transformers for 1,050,000 volt 60-cycle testing, sphere gaps and the 2¼ million volt impulse generator on the right. Other equipment for high current testing, power factor measurement, etc., is located in another section of the laboratory. An inspection trip to the Lapp Insulator Plant will be held June 24 during the Summer General Meeting.

Ladies' Entertainment

The Ladies' Entertainment Committee, headed by Mr. and Mrs. E. Sigmund, is arranging a series of special events for the 1958 Summer General Meeting. Every day, Monday through Friday, from 9:00 a.m. until 10:00 a.m., a Ladies' Coffee Hour will be held in the Grover Cleveland Room of the Statler Hilton Hotel. On Monday, from 1:00 p.m. until 5:00 p.m., a tour of the world-famous Kittinger Furniture Plant, in Buffalo, will be arranged. One of the highlights of this program, on Tuesday, June 24, at 12 noon, will be a ladies' fashion show and luncheon in the Rendezvous Room of the Statler Hilton Hotel. On Thursday, June 26, at 2:00 p.m. a ladies' tour of the General Mills Cereal Plant will be made. As noted, there will always be available the Ladies' Hospitality Room, where information concerning both the events and Buffalo proper may be easily obtained.

General Entertainment

Arrangements are completed for bus transportation and tickets for attendance at Melody Fair, Tuesday, June 24, and Wednesday, June 25. This will provide an opportunity to attend a theater-in-the-round presentation of leading Broadway musical comedies.

For the sports-minded men, a men's golf tournament is being set up at the Country Club of Buffalo. This will offer an opportunity of playing on one of the finest links in the area and will undoubtedly be enjoyed by all on Tuesday afternoon, June 24.

Hotel Reservations

With regard to hotel reservations, please bear in mind that this is the beginning of a busy summer season in the Niagara Frontier section. Everyone who has not already made reservations is urged to do so as soon as possible. Many fine motels are located within metropolitan Buffalo. Information concerning these motels and reservations available can be obtained from the Buffalo Convention and Tourist Bureau, 155 Franklin St., Buffalo.

Rooms have been set aside for members and their guests at the Statler Hilton Hotel. Reservation cards will be sent out with the meeting notices, listing the following accommodations:

Room and Bath	$ 6.00	$ 7.50	$ 9.00	$10.50
for One	6.50	8.00	9.50	11.00
Per Day	7.00	8.50	10.00	12.50
Double-Bed Room	9.00	10.50	12.00	13.50
with Bath	9.50	11.00	12.50	14.00
for Two Per Day	10.00	11.50	13.00	15.50
Twin-Bed Room	10.00	13.00	15.00	17.00
with Bath	11.00	14.00	15.50	18.00
for Two Per Day	12.00	14.50	16.00	20.00

More than Two Persons in One Room:
For each additional person in Double or Twin-Bed Room, the extra charge is $3.00 per day

Suite—Living Room, Bed Room, and Bath		
For One—Per Day		$30.00
For Two—Double Bed		33.00
—Twin Beds	$38.00	47.00

If a room at the rate requested is unavailable, one of the nearest available rate will be reserved.

MEETING DESIGNATION		NAME OF MEETING	CONVENTIONAL SCHEDULE	1958 DATE	1958 LOCATION	1958 PAPER CLOSING	1959 DATE	1959 LOCATION	1959 PAPER CLOSING	1960 DATE	1960 LOCATION	1960 PAPER CLOSING	1961 DATE	1961 LOCATION	1961 PAPER CLOSING	1962 DATE	1962 LOCATION	1962 PAPER CLOSING	1963 DATE	1963 LOCATION	1963 PAPER CLOSING	INVITATIONS DATE	INVITATIONS LOCATION
GENERAL	WG	WINTER	FEB 1ST WEEK	FEB 2-7	NEW YORK, N.Y.	OCT 14 1957	FEB 1-6	NEW YORK, N.Y.	NOV 3 1958	JAN 31 FEB 5	NEW YORK, N.Y.	NOV 2 1959	JAN 29 FEB 3	NEW YORK, N.Y.	NOV 1 1960	JAN 28 FEB 2	NEW YORK, N.Y.	OCT 30 1961	JAN 27 FEB 1	NEW YORK, N.Y.	OCT 29 1962	64 65	NEW YORK 64 2/2-2/7 NY 65 1/31-2/5 OR 2/7-2/12
	SG	SUMMER	JUNE 3RD 4TH WEEK	JUNE 22-27	BUFFALO, N.Y.	MAR 14 1958	JUNE 21-26	SEATTLE, WASHINGTON	MAR 23 1959	JUNE 19-24	ATLANTIC CITY N.J.	MAR 22 1960	JUNE 18-23	ITHACA, N.Y.	MAR 20 1961	JUNE 17-22	DENVER, COLO.	MAR 19 1962		TORONTO, CANADA		64	LOS ANGELES
	PG	PACIFIC	AUG.	AUG. 19-22	SACRAMENTO, CALIF.	MAY 21 1958				AUG. 8-12	SAN DIEGO, CALIF	MAY 10 1960	AUG. 23-25	SALT LAKE CITY, UTAH	MAY 25 1961		SAN FRANCISCO CALIF			SPOKANE, WASH.			
	FG	FALL	OCT.	OCT. 26-31	PITTSBURGH, PA.	JUNE 27 1958	OCT. 11-16	CHICAGO, ILL.	JUNE 12 1959	OCT. 9-14	CHICAGO, ILL.	JUNE 10 1960	OCT. 15-20	DETROIT, MICH.	JUNE 14 1961		CHICAGO, ILL.			CHICAGO, ILL.		64	CLEVELAND, O.
DISTRICT	D1	EMPIRE	EARLY MAY	JUNE 22-27	(SGM)	MAR. 14	APR. 29 MAY 1	SYRACUSE, N.Y.	JAN. 29 1959														
	D2	MIDDLE EASTERN	MAY	APR 28-30	WASHINGTON, D.C.	JAN. 28 1958	MAY 19-21	BALTIMORE, MD.	FEB. 18 1959		(SGM)		MAY 2-4	PITTSBURGH, PA.	FEB. 1 1961	MAY 14-16	ERIE, PA.	FEB. 13 1962					
	D4	SOUTH EAST	LATE MAR. EARLY APR.				APR 8-10	ATLANTA, GA	JAN. 8 1959				APR 5-7	NEW ORLEANS, LA.	JAN. 2 1961								
	D5	GREAT LAKES	LATE APR.	MAY 5-7	M.S.U. E. LANSING, MICH.	JAN 24 1958				APR. 27-29	MILWAUKEE, WISC.	JAN 27 1960	APR. 19-21	MINNEAPOLIS, MINN.	JAN. 19 1961	LATE APR.	FORT WAYNE, IND.						
	D7	SOUTH WEST	LATE MAR. EARLY APR.	MAR 31 APR 2	TULSA, OKLA.	DEC 20 1957				APR. 4-6	HOUSTON, TEXAS	JAN 4 1960				APR. 30 MAY 2	ST LOUIS, MO.						
	D11	EAST CENTRAL	EARLY MAY	MAY 13-15	HUNTINGTON, W. VA.	JAN 31 1958	APR. 22-24	AKRON, OHIO	JAN. 22 1959	MAY	CHARLESTON, W. VA.		MAY	CLEVELAND, OHIO		MAY	TOLEDO, OHIO						
	D12	NORTH EASTERN								MAY 2-4	PROVIDENCE, R.I.	FEB 1 1960				MAY 9-11	BOSTON, MASS.	FEB. 8 1962					
	D13	SOUTH CENTRAL					APR 8-10	JOINT WITH D4 ATLANTA, GA	JAN. 8 1959				APR 5-7	JOINT WITH D4 NEW ORLEANS LA.	JAN. 2 1961								
EASTER				APRIL 6			MARCH 29			APRIL 17			APRIL 2			APRIL 22			APRIL 14				

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
1958-1963 SCHEDULE OF GENERAL & DISTRICT MEETINGS

ISSUED BY:
J.D. TEBO
CHAIRMAN

AIEE Future Meetings

AIEE-ISA-IAS-ARS National Telemetering Conference (Exhibit)*
Lord Baltimore Hotel
Baltimore, Md.
June 2-4, 1958

Summer General Meeting*
Hotel Statler
Buffalo, N. Y.
June 22-27, 1958

AIEE-IRE Nonlinear Magnetics and Magnetic Amplifiers Conference (Exhibit)
Statler Hotel
Los Angeles, Calif.
August 5-8, 1958
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—June 2)

AIEE-IRE-NBS Electrical and Radio Standards Conference
University of Colorado and NBS (Dormitory Accommodations)
Boulder, Colo.
August 13-15, 1958
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—June 9)

Pacific General Meeting
Hotel Senator
Sacramento, Calif.
August 19-22, 1958
(Final date for †TP—closed, ‡CP Syn.—June 3, CPMs—June 13)

AIEE-NEMA National Electrical Insulation Conference
Pick-Carter Hotel
Cleveland, Ohio
September 7-10, 1958
(Final date for †TP—June 9, ‡CP Syn.—June 24, CPMs—July 3)

World Power Conference Sectional Meeting
Montreal, Que., Canada
September 7-11, 1958

Petroleum Industry Conference
Baker Hotel
Dallas, Texas
September 15-17, 1958
(Final date for †TP—June 17, ‡CP Syn.—July 2, CPMs—July 11)

Power Industry Computer Application Conference
King Edward Hotel
Toronto, Ont., Canada
September 15-17, 1958
(Final date for †TP—June 17, ‡CP Syn.—July 2, CPMs—July 11)

AIEE-IRE Industrial Electronics Conference
Park Shelton Hotel
Rockham Memorial Auditorium
Detroit, Mich.
September 24-25, 1958
(Final date for †TP—June 26, ‡CP Syn.—July 11, CPMs—July 21)

AIEE-ASME National Power Conference
Statler Hotel
Boston, Mass.
September 28-October 1, 1958
(Final date for †TP—June 30, ‡CP Syn.—July 15, CPMs—July 25)

AIEE-IRE-EIA-SMPTE National Electronics Conference
Hotel Sherman
Chicago, Ill.
October 13-15, 1958
(Final date for †TP—July 15, ‡CP Syn.—July 30, CPMs—Aug. 8)

Machine Tools Conference
Statler Hotel
Hartford, Conn.
October 13-15, 1958
(Final date for †TP—July 15, ‡CP Syn.—July 30, CPMs—Aug. 8)

Fall General Meeting
Penn-Sheraton Hotel
Pittsburgh, Pa.
October 26-31, 1958
(Final date for †TP—June 27, ‡CP Syn.—Aug. 12, CPMs—Aug. 22)

Magnetism and Magnetic Materials Conference
Sheraton Hotel
Philadelphia, Pa.
November 17-20, 1958
(Final date for †TP—Aug. 19, ‡CP Syn.—Sept. 3, CPMs—Sept. 12)

AIEE-IRE-ACM Eastern Joint Computor Conference (Exhibit)
Bellevue-Stratford Hotel
Philadelphia, Pa.
December 3-5, 1958
(Final date for †TP—Sept. 4, ‡CP Syn.—Sept. 19, CPMs—Sept. 29)

AIEE-IRE Second National Symposium on Communication Systems (Exhibit)
Colonial Inn-Desert Ranch
St. Petersburg, Fla.
December 3-5, 1958
(Final date for abstracts and summaries—Aug. 1)

AIEE-IRE-ASQC-EIA National Symposium on Reliability and Quality Control
Bellevue-Stratford Hotel
Philadelphia, Pa.
January 12-14, 1959
(Final date for †TP—Oct. 14, ‡CP Syn.—Oct. 29, CPMs—Nov. 7)

Winter General Meeting
Statler Hotel
New York, N. Y.
February 1-6, 1959
(Final date for †TP—Nov. 3, ‡CP Syn.—Nov. 18, CPMs—Nov. 28)

AIEE-IRE-U of P Transistor and Solid-State Circuits Conference
University of Pennsylvania
Philadelphia, Pa.
February 12-13, 1959
(Final date for †TP—Nov. 13, ‡CP Syn.—Nov. 28, CPMs—Dec. 9)

EJC Nuclear Congress
Cleveland, Ohio
April 5-10, 1959
(Final date for †TP—Jan. 5, ‡CP Syn.—Jan. 20, CPMs—Jan. 30)

South East-South Central District Meeting
Dinkler Plaza Hotel
Atlanta, Ga.
April 8-10, 1959
(Final date for †TP—Jan. 8, DPMs—Feb. 2)

East Central District Meeting
Akron, Ohio
April 22-24, 1959
(Final date for †TP—Jan. 22, DPMs—Feb. 16)

Rubber and Plastics Conference
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959
(Final date for †TP—Jan. 22, ‡CP Syn.—Feb. 6, CPMs—Feb. 16)

Empire District Meeting
Hotel Syracuse
Syracuse, N. Y.
April 29-May 1, 1959
(Final date for †TP—Jan. 29, DPMs—Feb. 20)

AIEE-IRE-EIA-WCEMA Joint Electronic Components Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
May 6-8, 1959
(Final date for †TP—Feb. 5, ‡CP Syn.—Feb. 20, CPMs—March 2)

Middle Eastern District Meeting
Lord Baltimore Hotel
Baltimore, Md.
May 19-21, 1959
(Final date for †TP—Feb. 18, DPMs—March 13)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Authors Guide*. For a copy, write to E. C. Day, AIEE, 33 W. 39th St., New York 18, N.Y.

Reservations must be received not later than 2 weeks prior to opening date of meeting and will be held only until 6 p.m. on day of arrival unless later hour is specified.

Committee

Members of the 1958 Summer General Meeting Committee are: D. J. Munhall, chairman; B. S. Rice, vice-chairman and secretary; L. J. Murphy, treasurer; W. F. Rauber, finance; W. J. Thompson, and K. J. Kelly, public relations; C. J. Brumbaugh, printing; W. K. Parks, hotel reservations and accommodations; G. W. Eighmy, registration; C. Lynn, hospitality; E. J. Rahill, program; J. P. Wood, technical papers; W. N. Carlson, meetings and properties; R. A. Beuerman, inspection trips; C. H. Sullivan, Jr., transportation; C. Gaylord, lunches and dinners; H. B. Vidal, entertainment; T. J. Brosnan, President's Reception and Banquet; C. M. Fogel, students; Mr. and Mrs. E. Sigmund, ladies program; C. W. King, special projects; M. O. Johnson, air transportation.

Forum at Summer General Meeting

The 18th Forum of Technical Committee Chairmen, Vice-Chairmen, and other members of the Technical Operations Department will be held in connection with the Summer General Meeting in the New York Room of the Statler-Hilton Hotel, Buffalo, N. Y., on the evening of June 25, 1958.

Featured will be talks by the chairman and vice-chairman of the Technical Operations Department and a "group dynamics" type of discussion to be conducted by Dixon Lewis.

Southwest District Meeting Held March 31-April 2 in Tulsa

TULSA, oil capital of the world and center of the "Magic Empire" region of Northeastern Oklahoma, was host to the AIEE Southwest District Meeting, March 31-April 2, 1958.

A total of 471 members, nonmembers, and guests attended.

The program was comprehensive and varied enough to be of interest to everyone. It included sessions on aircraft, engineering education, petroleum products, petroleum manufacturing, power generation, transmission, distribution, secondary distribution, and substation design, as well as industrial applications and communications.

Inspection trips were arranged to plants and industries in the Tulsa area: Douglas Aircraft Company, Tulsa Division; Nelson Manufacturing Company; Public Service Company of Oklahoma, Tulsa Power Station; D-X Sunray Oil Company, West Tulsa Refinery; and the Southwestern Bell Telephone Company's new long-distance telephone building.

General Session

The Honorable G. E. Norvell, mayor of Tulsa, extended a warm welcome to the assembly and offered the symbolic key to the city to Institute President W. J. Barrett.

President Barrett, in his remarks, took as his theme the unity of the engineering profession. He deplored the confusion and misunderstandings concerning the activities of the AIEE in this regard. The misunderstandings, he felt, were attributable in part to the lack of sufficient publicity on the subject. He stressed that all proposals of the AIEE to support three organizations of a character approximating the Engineers Joint Council, Engineers' Council for Professional Development, and National Society of Professional Engineers did not mean that the AIEE would withdraw into technical matters only, unconcerned about the general well-being of its members.

President Barrett urged all members to re-read his article on this subject entitled "The Functional Plan" which appeared in the February 1958 issue of *Electrical Engineering*.

The keynote address was delivered by R. K. Lane, founder of the Tulsa chapter of the AIEE, general chairman of the general meeting, and chairman of the board of directors, Public Service Company of Oklahoma. He spoke of the ferment of growth in Oklahoma caused by its transition from an agricultural to an industrial region.

Highlight of the address was a beautiful color film displaying a panorama of Oklahoma's burgeoning industrialization made possible by its energetic people and vast natural resources of forests, metals, water, and building materials.

Technical Sessions

Engineering Education. The increasing importance of technology, and the need for a larger number of engineers in the economy to meet the requirements of population growth and the technological threat of the Soviet Union was discussed by P. M. Honnell, of Washington University, St. Louis, Mo., in his paper "Electrical Engineering Education for the Future." He stressed the relation of engineering education to productivity, pointing out that the growing deficiencies of raw materials can be counter-balanced through wiser utilization of natural resources which requires technological skills and advances. Reliance on overseas for raw materials is not dependable because the former colonial dependencies from which these materials are obtained will need these raw materials for their own industrialization programs. The author stressed that a true engineering education must be liberal in the sense of freeing men's minds from ignorance, superstition, and fear so that they may be prepared to attack new problems with assurance, without hesitation, and without prejudices.

A companion paper was read by W. B.

Hopkins Photography Co.

AIEE PRESIDENT W. J. BARRETT (*center*) was made a chief of the Kiowa tribe at the dinner meeting of the Southwest District Meeting. The presentation, made by Kenneth Anquoe (*right*), was observed by R. K. Lane (*left*), general chairman of the District meeting. President Barrett's Kiowa name is Boin-ba-hait-kya-ta-to-ka, which in the Kiowa language means "Lightning Chief." Several Kiowa hoof dancers are shown in the background.

Jarzembski, Jarco Services, Inc., Tulsa, Okla. He urged the need for revising school curriculums so that fundamentals rather than operation is taught, emphasis being placed on the learning rather than the memorizing process.

Aircraft. The aircraft of the future is destined to provide good maneuverability at high speed and high altitude. The result is that construction materials will be subjected to high-temperature and the stresses from high thermal and physical shock. D. K. McIlvaine's paper, "Materials for Electrical Systems in High-Temperature Aircraft," considers the problems and materials for performance at a temperature range between —65 C and +500 C.

Although the development and test programs to date indicate a 500 C electrical system is feasible, much more effort is required to evaluate available materials, develop new materials, establish design data, establish workable procedures, and co-ordinate all fields of endeavor into a compatible system.

Other papers were the "Qualification Testing of Aircraft Electrical Systems," T. K. Johnson, General Electric Company, Lynn, Mass.; and the "Design Considerations for the *C-132* Electrical Power Systems," R. J. Robinson, Douglas Aircraft Company.

Power Transmission. The acquisition of rights-of-way for transmission lines is rapidly becoming a major problem for many electric utility companies. How the City Public Service Board of San Antonio, Texas, met this problem was discussed in H. C. Hughes' paper, "Narrow Base Steel Towers for Transmission Lines on City Streets." The problems of routing transmission lines and the procurement of the rights-of-way to service subdivisions all around the fringe areas of the city were formidable, he stated.

The narrow base tower combined with the use of post type or pin cap insulators can be used in many cases instead of an underground installation, the author pointed out. The cost is somewhat greater than the usual type of overhead line but substantially less than that of an underground line.

Companion papers were "Insulator Research for Tomorrow's Lines," A. D. Lantz, Ohio Brass Company; and "Wood Structures for 230 Kv and 345 Kv Construction," R. G. Yerk, Hughes Brothers, Inc.

Industrial Applications. The choice of a distribution transformer for a given industrial application is a problem of comparing many factors in order to obtain the best balance of qualities. F. J. Brutt, Westinghouse Electric Coropration, Sharon, Pa., in his paper "Comparison of Modern Industrial Distribution Transformers," compares the three basic types of transformers which are each more or less suitable for nearly all industrial plant applications. These are the mineral oil filled, the askarel filled, and the ventilated dry type. These transformers, which are used for industrial applications and secondary circuits, cover the range of 15 through 167 kva for single-phase and 30 through 300 kva for three-phase, both in the 600 volt and 5,000 volt class.

The paper discusses the needs of the consulting engineer in making his selection. Direct comparisons are made between the types and the limitations and problems imposed by the application, and recognized standards and codes are reviewed. Finally, the economics of the particular types are compared.

Also presented at this session was a paper on "Motor Operation and Protection on Unbalanced Voltages," by R. S. Reed and G. W. Cunningham, both of the General Electric Company.

Substations. "The Economics of Substation Standardization," T. R. Hoke, Oklahoma Gas & Electric Company, Oklahoma City, Okla., discusses the question "Is substation standardization economical?" The answer is not too obvious because most accounting systems are geared to record the costs of standardization, but generally do not reflect savings from standardization and are unable to indicate the losses from failure to standardize. Although the monetary savings from substation standardization will never bulk as large as the savings from distribution standards, the potential economies are far from negligible. Other papers read were "Consideration for Remote Data Logging," W. F. Cruess, Westinghouse Electric Corporation; and "Overload Capability of Modern Power Fuses," C. H. Baker, S & C Electric Company.

All-Congress Banquet Highlights 1958 Nuclear Congress in Chicago

"INDUSTRIALIZING THE ATOM" was the theme of the 1958 Nuclear Congress, held March 17-21 in Chicago, Ill. The Congress, sponsored by 31 leading engineering, scientific, and management groups and co-ordinated by the Engineers Joint Council, consisted of the 4th Nuclear Engineering and Science Conference, the Atomic Energy Management Conference, the 6th Hot Laboratories and Equipment Conference, and the Atomic Industrial Forum Atomfair

All-Congress Banquet

A highlight of the Congress was the banquet held Wednesday, March 19, at the Palmer House. L. L. Strauss, chairman of the Atomic Energy Commission, introduced the principal speaker, United States Vice-President R. M. Nixon. In a major policy address, Nixon challenged the Soviets to prove their "dedication to peace" by agreeing to preparatory meetings in which substance as well as form of proposed agenda items would be discussed. He stated that a conference not preceded by adequate preparatory discussions is "doomed to fail," and that a summit conference which failed would increase rather than reduce international tensions.

To meet the challenge of the space age, Vice-President Nixon pointed out the great need for a high-level public understanding to develop sound national policies with respect to space science and exploration. One of the major needs in this field is to develop a wider appreciation of the importance of the long-range benefits of basic research. In addition, he suggested that development of the United States outer space program not be limited to the military.

In reference to United States earth satellites now aloft, Vice-President Nixon said, "We must not permit a few successes to soothe our injured pride and lull us again into complacency and a false sense of security."

Technical Sessions

Over 150 papers were presented at the Nuclear Engineering and Science Conference, held at the International Amphitheatre. Of these papers, 18 were sponsored by the AIEE.

L. C. Noves of the General Electric Company described main coolant instrumentation for high-performance pressurized water reactor power plants. Among topics covered in the paper are design requirements for reactor temperature, pressure, flow, and liquid-level instruments.

Steam generator instrumentation for a nuclear plant with analog computer verification of dynamic action was the subject of a paper by E. E. Lynch and D. P. Waite of General Electric. "Swell," caused by steam bubbles raising the liquid level various amounts at different steam generation levels, poses an acute feedwater control problem. A solution involving the use of a computer setup is discussed in the paper.

E. P. Gyftopoulos and H. B. Smets of the Massachusetts Institute of Technology presented a paper on nuclear power plant transfer functions. A method is shown for the derivation of transfer functions from partial differential equations with respect to time and spatial variables, assuming that the heat transfer coefficients are independent of temperature.

A paper by R. H. Morse and R. N. Brey, Jr., of the Leeds and Northrup Company, describes a 3-element electronic feedwater control system for the experimental boiling water reactor. The description includes block diagrams of the control arrangement and simplified schematic diagrams of the control unit, bridge, bixer, and other elements.

L. E. Weisner of E. I. du Pont de Nemours & Co. (Inc.) presented a paper entitled "Transistor Count Rate Systems." Brief descriptions are given of all-transistor boron trifluoride counters, Geiger counters, and scintillation probes.

A paper by H. W. Bassett, Jr., and E. R. Gasser, both of the General Electric Company's Knolls Atomic Power Laboratory, discusses the control system on a turbine-generator supplying commercial power as a by-product of a nuclear test reactor.

F. C. Steiner of the Knolls Atomic Power Laboratory described a new method for the measurement of gases in high-pressure water reactor plants. The application is suitable to shipboard use and gives results in 5 to 10 minutes that agree

with those obtained by lengthy laboratory methods.

In the study of transients in nuclear and chemical plants, it is often necessary to consider the effect of variable transport lag caused by variable mass flow rate. A circuit to simulate such an effect is described in a paper presented by E. G. Holzmann of the General Electric Company.

A paper by K. L. Boring, R. F. Edgar, and L. H. Stauffer, all of General Electric, describes a magnetic, strong focusing system for a 60-inch cyclotron. It consists of a magnetic shielding channel, two quadripole focusing magnets, a remotely adjustable entrance aperture, and a magnetic beam analyzer. The system delivers several microamperes of 20-mev (million electron volt) deuterons or 40-mev alpha particles to a shielded target room.

Neutron detectors developed especially for high-temperature reactors are described in a paper by Edith Fehr of General Electric. These detectors are useful at temperatures up to 300 C.

Lester Kornblith, Jr., of the Vallecitos Atomic Laboratory, General Electric Company, described instrumentation of the Developmental Boiling Water Reactor, a small-scale power reactor supplying steam to a turbine operated by the Pacific Gas and Electric Company as part of their generating facilities. The discussion includes both the nuclear and steam sections of the instrumentation.

A paper by J. L. Cockrell of Leeds and Northrup and C. W. Ricker of the University of Michigan discusses the problem of trip point variation in a safety system. From experience it has been found that the actual trip power can vary over a significant range of reactor power. However, the highest power which the system could allow under any combination of circumstances (except failure of all channels) is determined by the situation present if only one channel receives the level information. Since this situation can be simulated during the set-up procedure, the ultimate trip point can be specified in advance.

W. H. Truran of the General Electric Company outlined some of the trends in radiation protection with nuclear reactors. Some of the criteria of an effective monitoring program are that it be continuous during normal operations, flexible during maintenance, and automatic during an incident.

"Design of Nuclear Laboratories" by D. I. Weinberg of Astra, Inc., emphasizes the personnel protection aspects of laboratory design. Facilities must be easily decontaminated in case of a spill, special precautions must be taken to prevent spread of contamination, and there must be adequate biological radiation shielding to protect personnel.

A paper by J. L. Cockrell, D. F. Ryan, and J. H. Magee, all of Leeds and Northrup, discusses modular concepts in reactor control instrumentation. The modular designs described are intended to correct many of the objectionable features found when ORNL (Oak Ridge National Laboratory) instruments are interconnected to form a reactor control system.

J. W. Adams, of Du Pont's Savannah River plant, described an automatic reactor power calculator which was designed to compute and record the rate of heat transfer from nuclear reactor heat exchangers. The reactor power value is obtained by multiplying the temperature rise by the flow rate of the cooling water passing through the exchangers.

FEATURE of the All-Congress Banquet, held in conjunction with the 1958 Nuclear Congress, was an address by United States Vice-President R. M. Nixon. At the speakers table are *(left to right)* R. D. Maxson, chairman, Local Arrangements Committee; B. R. Prentice, chairman, General Committee; J. R. Dunning, chairman, Nuclear Congress Policy Board; and Vice-President Nixon.

A paper by V. S. Underkoffler of Leeds and Northrup and R. G. Olson of Atomic Power Development Associates, Inc., covers a number of the design considerations for the nuclear safety instrumentation system of the Enrico Fermi Atomic Power Plant. The supporting experimental and simulation programs are discussed to illustrate the vast amount of information required for the conceptual design.

"Recent Developments in Personnel Radiation Dosimetry," by J. J. Fitzgerald and R. J. Feinberg of General Electric, describes the development of three personnel detectors for beta, gamma, and neutron radiations. Each of these dosimeters is discussed with respect to quality and quantity of radiation detected, reliability and ruggedness of the detectors, sensitivity, and versatility.

Exhibits

Over 100 American industries set up exhibits at the Atomfair, held at the International Amphitheatre, March 17-21. A preview was held Sunday, March 16, 1958, for 4,500 high school students of the Chicago area, selected for their interest in and aptitudes for science.

The exposition, showing the newest achievements in the nuclear field, emphasized the application of atomic energy to industry. On view were numerous models

A CENTER-PANEL CUTAWAY of a nuclear power reactor, with simulated action, features ALCO Products, Inc.'s exhibit at the Atomfair, part of the 1958 Nuclear Congress in Chicago, Ill.

of reactors, including several "push-button" types so designed that visitors could operate the controls.

A model was displayed of the dual-cycle boiling reactor for the Commonwealth Edison Company's Dresden nuclear power station, located 47 miles southwest of Chicago on the Illinois waterway. The General Electric Company will complete this station for Commonwealth Edison by 1960.

Also exhibited by General Electric was a model of the "Beetle," a manned, self-propelled vehicle equipped with manipulator "arms" to serve power plants of the type which will drive nuclear-powered aircraft.

The American Machine & Foundry Company's AMF Atomics Division featured a closed-cycle boiling-water power reactor in its exhibit. In addition, the company displayed a full-size reactor grid plate with dummy fuel element loading.

The Nuclear-Chicago Corporation announced and exhibited for the first time an actual working subcritical nuclear reactor designed for educational purposes. It was operated with a radium–beryllium neutron source and 2,500 kilograms of natural uranium.

A cobalt-60 irradiator was demonstrated by Atomic Energy of Canada Limited, Commercial Products Division. Samples having volumes up to 220 inches can be irradiated with dose rates exceeding 1 million roentgens per hour.

The exhibit of ALCO Products, Inc., featured the functions within the core of the pressurized-water reactor system designed and built by ALCO for the Army Package Power Reactor (APPR-1) at Fort Belvoir, Va.

The "Thimble Loading Machine," which handles radioactive materials under 18 feet of water and which operates on its own small railroad track, was shown by the Westinghouse Electric Corporation. The device was built for Westinghouse by General Mills, Inc. It will be installed later this year in the Westinghouse Testing Reactor at Waltz Mill, near Pittsburgh, Pa.

Translations of USSR Scientific and Engineering Journals Available

AS ANNOUNCED in Electrical Engineering, February 1958, p. 173, the translations of four leading Soviet scientific and engineering journals in the field of power transmission, communications, and electronics are now available by arrangement with the Pergamon Institute, a nonprofit organization.

Following is a listing and prices of the publications available on an annual subscription basis:

Journals	List Price
(1) "Elektrischestvo" Electric Technology, USSR (quarterly)	$56 per year*
(2) "Radiotekhnika I Elektronika" Radio Engineering and Electronics, USSR (monthly)	$45 per year*
(3) "Radiotekhnika" Radio Engineering, USSR (monthly)	$30 per year*
(4) "Elektrosviaz" Telecommunications, USSR (monthly)	$30 per year*

*50% discount of list prices is available to AIEE Members and members of such other organizations as may be arranged.

AIEE members only should send subscriptions and remittance to: N. S. Hibshman, Secretary, American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

Libraries, research laboratories, Government departments, companies, etc., should send orders to: Pergamon Institute, 122 E. 55th St., New York 22, N. Y.; or 4 & 5 Fitzroy Square, London W. 1, England.

Sample Contents Lists

The following are sample contents lists of two of the publications.

The contents for Volume 2 of "Electric Technology USSR," which are listed here, are at present being edited and will be going to production shortly; Volume 1 should be ready in the very near future; Volume 3 is in translation.

Electric Technology USSR—Contents Volume 2, 1957

Sokolov, N. I. Stability of a Transmission System with Controlled Synchronous Condensers at a Substation Making Sections.
Slezhanovskii, O. V. Controlling a Mill with Separately Driven Rollers.
Belyakov, N. N. Investigation of Overvoltages due to Arcing Earth Faults in 6-10 Kv Systems with Insulated Neutral.
Gusa, V.; Tsigelka, Ya. Arc-Quenching Processes in Air-Blast Circuit-Breakers.
Kamenetskii, M. O. Determination of In-Feed Currents (from Induction Motors) to Short-Circuits in Low-Voltage Systems.
Burgsdorf, V. V. Wind Pressure on Overhead Transmission Line Conductors.
Kozhin, A. N. The Protection of a Regulating Autotransformer.
Zherdev, I. T. The Current in the Charge Materials of a Ferrosilicon Furnace.
Neiman, Z. B. Large Synchronous Motors with Solid Poles on the Rotor.
Titov, B. V. and Kogan, Z. B. Turbogenerator Rotor with Direct Cooling of the Winding Conductors.
Kraiz, A. G. High-Voltage Autotransformers.
Smirnova, T. I. A New Air-Blast Circuit-Breaker for 220 Kv, 7,000 Mva.
Pertsov, G. I. A Method for Thermal Calculations of Mining Combine Motors.
Karniushin, L. V. Velocity-Time Relations for Electric Drives for Intermittent Operations.
Strakhov, S. V. A Method of Deriving Equations for the Electromechanical Transient in Electric Circuits.
Bal'chitis, A. A. The Induction Law for an Electrostatic Machine.
Morozov, D. P.; Bortsov, Yu. A. Generalized Method of Investigating the Transient Processes in Electric Drive Systems.
Krawchenko, V. D.; Levitov, V. I.; Popkov, V. I. The Measurement of Corona Losses on Live Transmission Lines.
Tsuernik, L. V. and Kachanova, N. A. Analysis of Static Stability of Complex Power Systems by Electronic Computers.
Gimoyan, G. G. Practical Methods of Calculating Relays with Rectifiers.
Lopshits, L. M. The Nomogram for Determining Protective Zones of Lightning Conductors.
Kuchinskii, G. S. and Litvinova, E. L. Thermal Systems of Isolation of Condensers.
Glants, Yu. A. The Use of Load Distribution Diagrams for the Design of Urban Systems.

Radio Engineering and Electronics USSR—Contents No. 1, 1957

Editorial
Tzimring, Sh. E. Calculation of Waveguides with Periodic Unhomogeneities by Variation Method.
Tartakovsky, G. P. Stability in Linear Impulse Systems of Variable Parameters.
Tihonov, V. I. The Effect of Differentiating and Integrating of Fluctuations upon Average Number of Variations.
Gorelick, G. S.; Elkin, G. A. The Transformation of Amplitude and Phase Fluctuations in Resonant Systems.
Trottzky, V. N. The Effect Produced by Structural Function Form of Unhomogeneities in Air Dielectric Permeability upon Distant Tropospheric Propagation of Ultrashort Radio Waves.
Gurevitch, M. S. The Frequency Band Employed for Impulse Transmission.
Utkin, G. M. Mutual Synchronization of Autogenerators at Multiply Frequencies.
Prozorovsky, J. N. Distributed Amplifier as a System of the Multipole Networks.
Persikov, M. V. Directional Coupler for H_{11} Mode in the Circular Waveguide.
Elinson, M. I.; Zernov, D. V. Electron Emission Mechanism of Thin Dielectric Layers Subjected to a Strong Electric Field (Malter's Effect).
Timofeev, P. V. Electronic Emission from Complex Surfaces.
Blioh, P. V. High-Frequency Oscillations in Electronic Beams of Periodically Varied Speed.
Shevchik, V. N. Analysis of Energy Interchange between the Electronic Current and the Electromagnetic Wave.
Shpigel, I. S.; Raizer, M. D.; Miae, E. A. Instruments for Relative Measurements of Variable Magnetic Fields.

Notes and News
Gershstein, G. M.; Vitels, G. L. Expansion of Fluctuating Zones in Magnetrons of Decimetric Range.
Prozorovsky, J. N. On the Input Conductance of Pentode.

Letters to the Editor
Bernashevsky, G. A. Spatial Harmonics of Electronic Wave.

Radio Engineering and Electronics USSR—Contents No. 2, 1957

Editorial
Malov, N. N. Heinrich Rudolph Hertz (100 years since birthday).
Vasiliev, R. R. Static Methods of Phototelegram Transmission.
Voronin, E. S.; Rogatnev, I. I. The Unstable Processes in Autogenerator with Direct Excitation by Radio Impulses.
Kazantzev, Y. N. Calculation of Symmetrical Transitive Devices in Waveguides of Circular Section for the Waves of Type Hon.
Nikolsky, V. V. Girothropic Excitation of Waveguide.
Mirimanov, R. G.; Zhileiko, G. I. Analysis of Diaphragmed Waveguides of Certain Types.
Upatov, V. Y. Method of Potential Distribution Measurement on the Surface of Dielectrics.
Upatov, V. Y. The Electric Field of a Charged Spot Produced by Electronic Beam on the Surface of Dielectric P.I.
Elinson, M. I.; Gorkov, V. A.; Vasiliev, G. F. Study of the Method Applied for Reduction of Autocathode Bombardment by the Loss of Residual Gases.
Rompe, R. Certain Research on "Cold" Electronic Omission of Sulphurous Cadmium Monocrystals.

PRESENT: Engineering Societies Building

FUTURE: Site for new United Engineering Center

◄ **NOONDAY scene in front of entrance to present Engineering Societies Building on 39th Street in New York City.**

► **SITE (*foreground*) of future United Engineering Center, where most of the demolition has been completed. View, looking southeast, includes United Nations Building (*left*) and Carnegie Foundation Building (*right*).**

◄ **VIEW, looking northwest on 39th Street, of present Engineering Societies Building.**

► **VIEW, from United Nations Plaza, includes: (*left to right*) International Business Machines Corporation Building, Carnegie Foundation Building, and site (*arrow*) of future United Engineering Center, between 47th and 48th Streets.**

International News Photos

Tager, A. S. Research on Noise Property of Traveling Wave Values.
Shevchik, V. N.; Stalmahov V. S., The Effect of Special Charge upon Interaction between the Electronic Flow and the Travelling Magnetic Wave.
Shevchik, V. N.; Zarkov, Y. D. Cascade Grouping of Electrons for Application to Analysis of Interaction between the Electronic Flow and the Travelling Electromagnetic Wave.
Shtirov, A. L. Homogeneous Delay Systems Interpretation.

Notes and News
The Second Symposium on Theory of Information in U.S.A.
Interdepartmental Seminar on Cathode Electronics.

Radio Engineering and Electronics USSR
—Contents No. 3, 1957

Editorial
Kozhevin, V. E.; Loshkarev, V. E. The Effect of External Potential and some other Factors on Capacity Photoresponse of Semiconductors.
Liashenko, V. I.; Snitko, O. V. The Effect of Molecules and External Electrical Field on Photoconductivity of Semiconductors.
Chepoor, D. V. Photoelectrical and Optical Properties of H_gJ_2.
Berlaga, R. J.; Rumsh, M. A.; Strakhov, L. P. Photo-EMF in Layers of Sulphurous Lead.
Politov, N. G. The Centers of Coloring in Crystals KCl and KCl with Admixture Ag.
Skvortzova, N. E. The Study of Input Resistances and the Control of Equivalent Scheme of Germanium Detectors in the Frequency Range of 1,000–10,000 Mc.
Bonch-Brooevitch, A. M.; Soltamov, U. B. The Study of Transistor Characteristics with Oscillographic Characteriograph.
Bonch-Brooevitch, A. M., Imas J. A. Some Questions of the Application of Semiconductors Bolometers.
Bogoliuboy, V. F. New Modification of the Capacity Method for Measurements of Potential Difference and Its Application to the Study Contact Potentials of Semiconductor.
Lookirsky, A. P. The Vacuum X-ray Spectograph with Geiger Counter for Research in Power Levels of Solid Bodies.
Kondorsky, E. I.; Pakhomov, A. S.; Shiklosh, T. Theory of Spontaneous Magnetization of Ferrites.
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Varchenia, S. A.; Dorfman, J. G. Thermoelectric Properties of Ferrites in the Range Close to Curie Temperature.

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Elinson, M. L.; Vasiliev, G. F. Experimental Research on Field Emission of Boxabroid Iantan.
Demidov, K. K. Inertness of Internal Photoeffect in Chlorous Silver.

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Aronberg, A. G. (obituary)
International Colloquium on Current Problems of Radio-Waves Propagation.
Interdepartmental Seminar on Cathode Electronics.

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—Contents No. 4, 1957

Editorial

Hoorgin, J. I. The Casual Impulse Processes of a Class.

Fortakovsky, G. F. The Stationary Casual Processes on Line Impulse Systems of Variable Parameters.

Pokrovsky, V. L. The Design of Optimum Serials with Longitudal Axial Emission.

Fsorover, J. M. The Method of Calculation of Local Reflection Coefficients at the Optimum Stages of Transitions.

Varosova, A. V.; Goorevitch, A. G. Calculation of the Propagation Constants in Rectangular Waveguide Equipped with Ferrite Plates.

Monssov, J. A. Certain Questions on Cylindrical Waveguides with Ferrite Spindle.

Lisitzian, R. R. On Generator Catching by Frequency of an External Force.

Markov, G. T. Excitation of the Ellipsoid Generated by Rotation.

Malahov, A. N. Fluctuations of the Amplification Coefficient of Vacuum-Tube Amplifier.

Falkovitch, S. E. On Precision in the Reckoning of a Distance Co-ordinate on Radiolocation Systems.

Loshakov, L. N. The Application of Lorentz's Iemma for Determination of the Constants of Propagation at the Interaction of Electronic Flow with Special Harmonics.

Nielmah, M. F. Interaction of the Electronic Flow with the Field of Special Harmonics.

Veselago, V. G., Irinova, N. A. Modulation Scheme for Frequency Stabilization of the Reflecting Klystron by Means of Volumetric Wavemeter.

Fetisov, D. V.; Millutin, V. I. Asymmetry of Elements in Optical System of the Electrostatic Microscope and its Resolving Capacity.

Nedospasov, A. V.; Torgonenko, K. E. The Range of the Low-Voltage Arc in the Inert Gases.

Briefs

Tihonov, V. I. The Method for Determination of Quasi-Harmonic Fluctuations Bending.

Atkin, V. S. Modulation of Carrier by Means of Change in Magnetic Permeability of Ferromagnetic Conductors.

Viasemsky, V. O. Possibilities for Construction of Quick-Acting Amplitude Analyser.

Letters to the Editor

Prohorov, A. M. The Effect of a Good Quality Resonator on Frequency of Molecular Generator.

Notes and News

Koulvarskaya, B. S.; Iasnopolskaya, A. A.; Alpatova, N. A. Interdepartmental Seminar on Cathode Electronics.

Conference To Be Held at NBS Boulder Laboratories

A Conference on Electronic Standards and Measurements will be held at the NBS (National Bureau of Standards) Boulder Laboratories, Boulder, Colo., August 13-15, 1958, under the joint sponsorship of the AIEE, Institute of Radio Engineers (IRE), and the NBS. The Conference will be devoted to new developments, techniques, and problems of measurements. It will also include the dedication of the new Electronic Calibration Center of the NBS. Inspection of the facilities of NBS new operation should be of considerable interest to the Conference participants.

Today's vital interest in science and the ever-increasing need for instrumentation are a challenge for the improvement of standards and measurement techniques. In no field is this challenge greater than in electronics, as witnessed by missile control, automation, electronic computing machines, radar, and navigation systems. The very complexities of these devices require that instrumentation and measurement techniques be based upon well-ordered systems of standards. To provide a means for interchange of ideas in this field on a national level, the AIEE, IRE, and NBS are sponsoring this Conference.

The 1958 Conference will be divided into six main sessions: relationship of standards to physical constants, frequency and time interval standards, direct-current and low-frequency standards, radio frequency standards, microwave standards, and the organization and operation of standards laboratories.

Fortescue Fellowship Award Announced for 1958-59

The Charles LeGeyt Fortescue Fellowship Committee of the Institute has awarded a fellowship for graduate study in electrical engineering during the academic year 1958-59 to T. J. Harley, Jr.

Dr. J. F. Calvert, of the University of Pittsburgh, is chairman of the committee administering the award for the Institute.

Born January 31, 1929, in Philadelphia, Pa., T. J. Harley, Jr., graduated from the University of Pennsylvania in 1951 with a bachelor of arts degree, having majored in mathematics.

Following graduation, he was employed by the U.S. Government in Washington, D.C., as a mathematician. He entered the U.S. Army in 1954 and was assigned to the Scientific and Professional Personnel Program with the Ordnance Corps, Development and Proof Services, Aberdeen Proving Ground, Md., as a mathematician, where he processed data of tests on fire-control systems.

After being released from the Army to inactive duty in January 1956, Mr. Harley returned to the University of Pennsylvania Moore School to study electrical engineering. His activities while at the Moore School have included: chairman of AIEE-IRE (Institute of Radio Engineers) Joint Student Branch; Moore School chairman of Engineers Day, 1957; and a representative to Moore School student government. Honors and awards include: election to Tau Beta Pi and Eta Kappa Nu honor societies, achievement of Honors for academic year 1956-57, and the Warwick Memorial Award (awarded by the American Society for Testing Materials annually to a member of the Junior class in each of the engineering schools, who is ". . . an outstanding student for the year in the courses in materials and allied subjects."). He also tied for first place in the Student Branch AIEE prize paper contest.

T. J. Harley, Jr.

Mr. Harley will receive the B.S. degree in E.E. in June 1958. He plans to continue his studies at the University of Pennsylvania.

The fellowship was established in 1939 by the Westinghouse Electric and Manufacturing Company (now Westinghouse Electric Corporation) as a memorial to Charles LeGeyt Fortescue for his contributions to the electric power industry.

Dr. Fortescue, who was graduated from Queens University, Kingston, Ont., Canada, as the University's first electrical engineer in 1898, received 185 patents on electrical inventions during his 38-year career with Westinghouse.

Conference on Magnetism and Magnetic Materials Is Planned

The fourth Conference on Magnetism and Magnetic Materials will be held in Philadelphia, Pa., November 17-20, 1958, at the Sheraton Hotel. This Conference is sponsored by AIEE in co-operation with the American Physical Society, Institute of Radio Engineers, the Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers, and the Office of Naval Research.

Those interested in presenting papers at the Conference should submit titles of proposed papers by August 1 and abstracts by September 1, to the Program Chairman, H. B. Callen, Department of Physics, University of Pennsylvania, Philadelphia, Pa.

Further details may be obtained from C. J. Kriessman, local chairman, Remington Rand Univac, 1900 W. Allegheny Ave., Philadelphia, Pa.

Michigan Section Presents Symposium

The Industry and Education Committees of the Michigan Section of AIEE jointly presented a Symposium on Industrial Electrical Power Systems in eight weekly sessions at The Detroit Edison Company.

Qualified authorities in the design, operation, and maintenance of plant distribution systems presented lectures covering system planning, voltage considerations, relaying, and cost analysis.

The lectures amplified prescribed reading from AIEE Publication No. 952, Electric Power Systems for Industrial Plants, which was used as a text by the study group.

Of the more than 400 applicants for the

study group, only 240 were admitted for lack of seating facilities. This overwhelming response contributed to an eminently successful symposium which is a fine example of what enthusiastic advertising by committee members and sales groups in the area can accomplish. The gratifying response may well be indicative of the need for such study groups in similar fields as well as in other parts of the country.

The engineers, technicians, and industrial plant personnel composing the study group paid a nominal fee of $10 covering costs of the texts and incidentals. The Michigan Section plans to repeat the study group in the Fall of 1958.

AT THE FIRST SESSION of the Symposium on Industrial Electrical Power Systems sponsored by the Michigan Section of AIEE, Section Chairman H. M. Hess *(left)*, associate dean of the College of Engineering, Wayne State University, greets the speaker, J. P. Smith *(right)*, applications engineering, General Electric Company, Detroit, Mich.

Annual Pulp and Paper Industry Conference Held

The Fourth Annual Conference on Electrical Engineering as Applied to the Pulp and Paper Industry, held March 27-28, 1958, in Riddick Engineering Building on the campus of North Carolina State College, Raleigh, N. C., was attended by 125 electrical engineers from the mills and allied industries. Attendance was from widespread areas and included mill electrical engineers from as far away as Maine, Minnesota, and Texas.

The two-day Conference was highlighted by an interesting program of technical papers and timely addresses.

Addresses of welcome were given by Dean J. H. Lampe, school of engineering, and Prof. H. D. Cook, school of forestry, both of North Carolina State College.

H. J. Malsburger, director, Southern Pulpwood Conservation Association, gave an enlightening luncheon address on March 27 at the College Union Ballroom. He said that "In the South, the woods are full of prosperity." In explaining the activities of the Conservation Association, Mr. Malsburger stated "The objective of our Association is to help the other fellow grow wood on his land." He further stated that 70-80% of the pulp used in the South comes from privately owned farms of 100 acres or less.

Dr. Newton Underwood, professor of physics at the College, addressed the banquet held the evening of March 27 at the Sir Walter Hotel. Speaking on the subject of "Radiological Hazards," Dr. Underwood stated that "The difference between a dead rabbit and a happy rabbit is one-half hour of exposure to 1,000 Roentgens." He further pointed out that all anyone could do with radioactive material is to move it— "a question of disposition rather than disposal." At the present time, the southern tip of Florida is the least radioactive spot in the United States. The highest counts have been recorded in Cincinnati and Boston, caused by the prevailing winds. In pointing out that there is no threshold value for determining damage from ionizing particles, Dr. Underwood stated that the amount of radioactive pollution this nation can tolerate "should be decided on the basis of wisdom, morality, and philosophy." In other words, we must "weigh any solution in terms of gains against losses."

Inspection trips, held the afternoon of March 28, included on-campus visits to the research reactor at the Burlington Nuclear Laboratories, and the recently

PRESENT at the Pulp and Paper Industry Conference (above, *left*) are: (*left to right*) G. I. Burner, Rust Engineering Company, Pittsburgh, Pa., chairman of the AIEE Pulp and Paper Industry Subcommittee; C. H. Hudson, General Electric Company, Atlanta, Ga., Subcommittee vice-chairman and Conference program arrangements chairman; and Prof. W. D. Stevenson, Jr., School of Electrical Engineering, North Carolina State College. *Right:* Discussing some of the conference papers are: (*left to right*) T. D. Roberts, Albany, Ga.; S. T. Bates, Charlotte, N.C.; and S. A. Bobo, Atlanta, Ga., all of Westinghouse Electric Corporation.

dedicated Reuben B. Robertson Laboratory of Paper Technology.

The AIEE Pulp and Paper Subcommittee Meeting was held March 26 at which time G. I. Burner, chairman, announced that the Conference for 1959 would be held at the University of Maine. Tentative dates of June 11-12 have been set for this conference. T. A. Likos, Westinghouse Electric Corporation, Boston, Mass., was appointed program chairman for the 1959 Conference. Mr. Burner also announced that the Conference for 1960 would again be held in the southern states area.

The success of the 1958 Conference was the result of excellent co-operation and assistance of North Carolina State College's Schools of Engineering and Forestry and the North Carolina Section of the AIEE.

Annual Meeting of NSPE June 11-14 in St. Louis, Mo.

Presentation of the 1958 National Society of Professional Engineers (NSPE) Award to N. W. Dougherty, dean emeritus of engineering at the University of Tennessee, will highlight the annual meeting of the NSPE in St. Louis, Mo., June 11-14, 1958.

The eighth individual to receive the award since it was first made in 1949, Dean Dougherty served as a member of the faculty of the College of Engineering for 40 years before his retirement in 1956. He is currently engaged in consultation work for the Arnold Engineering Development Center.

Dean Dougherty will be presented with a plaque at the final banquet session on June 14. Others having received the award are: Herbert Hoover, 1949; D. B. Steinman, 1952; C. F. Kettering, 1953; H. A. Winne, 1954; A. A. Potter, 1955; D. A. Quarles, 1956, and G. M. Read, 1957.

The educator was chosen for the award ". . . in recognition of his outstanding leadership in his profession as evidenced by his devotion to the advancement of engineering education, his sympathetic encouragement of students of engineering, his zealous promotion of the ideals and principles of his profession, and his humanitarian interest in his fellow men."

Dean Dougherty acted as chairman of the Tennessee State Board of Examiners for Architects and Engineers from 1927 to 1957. He is a past president of the National Council of State Boards of Engineering Examiners, a past president of the American Society for Engineering Education (ASEE), and a past vice-president and national director of NSPE.

At the meeting's first event, an NSPE Past Presidents' Dinner on June 11, former presidents will be honored. R. R. Tucker, mayor of St. Louis, is slated to welcome the group at this time, and NSPE President G. H. Dyer will speak on "The State of the Society."

Of major importance at this 24th annual meeting at the Chase-Park Plaza Hotels will be a series of functional section conferences on June 13 devoted to the engineer in industry, education, private practice, and Government.

A combined functional section conference will be held by industry and education. The theme for this group is "Professional Development of Engineering Students for Professional Careers." J. J. Ryan, engineering professor at the University of Minnesota, is scheduled to speak on "The Professional Course—Today and Tomorrow." J. N. Thompson, chairman of NSPE's Student Chapters Committee, will talk on "The Role of the Student Chapters." Among other topics to be discussed will be "What Professional Concepts Industry Expects from Engineering Graduates" and "Continuing Education after Graduation."

A. C. Kirkwood, chairman of the Engineering Practices Committee, will moderate the conference for the engineer in private practice. The discussion will cover fees and the language of fees, adherence to recommended minimum fee schedules, professional ethics, professional liability insurance, and employer–employee relations.

L. N. White, chairman of the Engineers-in-Government Subcommittee, will lead the discussion in regard to the formation of a functional section for engineers in the employ of Government. To assist the group in their planning, the following persons will participate in the discussions: C. R. Hanes, chairman of NSPE's Functional Section Services Committee; F. G. Manning, chief engineer, Department of Public Works, Jersey City, N. J.; and M. F. Lunch, legislative counsel for the NSPE.

Also on the agenda for June 13 is a report by Prof. G. R. Henninger, Iowa State College, of a national survey taken of technical institute education. This year-and-a-half study has been conducted by the Technical Institute Division of ASEE through a grant from the Carnegie Fund. Prof. Henninger is director of the project and will present the results of the study as it pertains to the role of the engineering technician in relationship to the work of the professional engineer. This report will be part of an entire afternoon's program devoted to a broad discussion of the technician.

Professional meetings will resume on June 14, with a luncheon to feature an address by J. M. Dalton, attorney general for the State of Missouri. He will talk on "The Role of the Professional Engineer in State Government."

The NSPE is composed of approximately 45,000 registered, professional engineers in all the technical branches. The members are affiliated through 46 state societies, and over 375 local chapters.

AIEE Pacific General Meeting

COMMITTEE CHAIRMEN who are planning the AIEE Pacific General Meeting, August 19-22, 1958, at Sacramento, Calif., are shown gathered at their first planning meeting in January. They are: (*top row, left to right*) M. R. Davis, publicity; R. O. Syron, registration; L. O. Haupt, Jr., inspection and field trips; E. J. Keogh, sports and recreation; J. E. Chester, meeting; R. W. Armstrong, student activity; (*front row, left to right*) P. E. Shaad, finance; W. G. Felt, treasurer; F. J. Groat, vice-chairman; C. R. Day, chairman; W. L. Hill, secretary; Mrs. F. J. Groat, ladies program; I. E. Ball, entertainment. Chairmen not shown are: E. R. Price, lodging arrangements; and A. O. Clark, printing and tickets.

News of the Insulated Conductors Committee

Emphasis is placed at present on the development of extrahigh-voltage (300- to 400-kv) power cable because of the need for such cable in the forseeable future.

Because of the importance of electrical insulation in this development, the Insulations Subcommittee of the AIEE Insulated Conductors Committee has been active in studying insulating materials that might

be considered for this purpose. This study covers oil-impregnated paper insulation which is used at present in high-voltage power cables, and also the newer synthetic materials which are becoming available. The purpose is to look for a material, or combination of materials, which has an exceptionally low dielectric loss sustained under all operating conditions during a long life of the cable, and also is acceptable with respect to all other requirements placed on cable insulation for this application.

The Insulations Subcommittee is active also with respect to insulation for other cable applications, and occasionally sponsors symposiums at AIEE General Meetings covering a specific material. A good example is the "Symposium on Polyethylene Wire and Cable Insulation," held last year in co-operation with the Dielectrics Committee, in which 10 papers were presented during two sessions. These 10 papers are planned as an AIEE special publication.

CIGRE Officers for 1958 Announced

W. S. Price (M '56), electrical research engineer of American Gas & Electric Service Corp., was elected secretary-treasurer of the U.S. National Committee of the International Conference on Large Electric Systems (CIGRE) at the committee's annual meeting in New York, N. Y. Mr. Price, widely known in this country and abroad for his work in the design of extra-high voltage transmission line, succeeds I. W. Gross (F '45).

Re-elected as officers of the U.S. National Committee for 1958 were: Chairman, Philip Sporn (F '30), president, American Gas & Electric Corp.; and Vice-Chairman H. L. Melvin (F '31), chief consulting engineer, Ebasco Services. Frederic Attwood, vice-president, Ohio Brass Company, was renamed honorary head of the 21-man United States Committee. C. W. Franklin (F '44), electrical engineer, Consolidated Edison Company of New York, Inc., was re-elected chairman of the committee's Technical Subcommittee.

Known among engineers by the abbreviation of its French name, Conference Internationale des Grands Reseaux Electriques, CIGRE was founded in 1921 and is today one of the oldest and by far the largest international electrical engineering organization in the world. Its purpose is to study technical problems associated with the design, construction, operation, and interconnection of large high-voltage power systems. Membership is open to all engineers interested in large power systems. Present membership totals 2,200 engineers from 51 countries throughout the 5 continents.

The U.S. National Committee, like its counterparts from the 50 other countries participating in CIGRE, plans and co-ordinates the participation of United States members in CIGRE's 18 International Study Committees as well as in its biennial conferences.

U. S. National Committee is currently engaged in planning the United States participation in the 17th biennial convention of CIGRE to be held this year in Paris, France, June 4-14. Purpose of the convention is to report developments in the technology of large high-voltage power systems.

At Paris, this year, 8 of the more than 130 technical papers to be presented will be offered by engineers associated with electric utilities, electrical manufacturers, and engineering colleges in the United States. Selection and organization of the American technical program to be presented at Paris has been under the direction of C. W. Franklin, who for the past two years has headed the Technical Subcommittee of the U.S. National Committee.

United States attendance at the 1958 Paris convention is expected to exceed the more than 60 who attended in 1956. Attendance is unrestricted and open to both members and nonmembers of CIGRE. The registration fee of 20,000 French francs ($47.50) for members; 25,000 francs ($60) for nonmembers covers the cost of all English translations of technical papers to be presented at the Paris meeting. Registration forms and applications are available from the Paris headquarters of CIGRE, 112 Boulevard Haussmann, Paris, France, or by writing to the U. S. National Committee, CIGRE, 50 Church Street, New York, N. Y.

Several changes have been made in the United States membership on International Study Committees of CIGRE in recent months as follows:

C. H. Titus (M '47), laboratory department of General Electric Company, Philadelphia, Pa., has replaced E. C. Rietz (M '52), engineering manager, General Electric Company, Philadelphia, on CIGRE Committee No. 3 concerned with High Voltage Switching and Circuit Breakers.

W. K. Sonneman (F '56), consulting engineer, Westinghouse Electric Corporation, Newark, N. J., has replaced S. C. Leyland (F '51), manager, relay department, Westinghouse Electric Corporation, Newark, as a member of CIGRE Study Committee No. 4 concerned with Protection and Relaying.

L. W. Morton (F '51), manager, power conversion engineering, General Electric Company, Schenectady, N. Y., has been named adviser to CIGRE Study Committee No. 10 concerned with Direct Current Transmission Lines at Extra High Voltage.

Dr. E. T. B. Gross (F '48), professor of power systems engineering at Illinois Institute of Technology, Chicago, Ill., has been named adviser to CIGRE Study Committee No. 13 dealing with System Stability and Load Frequency Control.

International Meetings of Interest to Engineers

During September 1958, there will be held in Canada and the United States a series of international meetings of prime importance to engineers. The meetings and tours are arranged in series to permit

Lamme Medal 1958 Nominations Due December 1

Special attention is directed to the fact that the names of Institute members who are considered eligible for the AIEE Lamme Medal to be awarded early in 1959, may be submitted by any member in accordance with section 1 of Article VI of the bylaws of the Lamme Medal Committee as follows:

"The committee shall cause to be published in one or more issues of *Electrical Engineering*, or of its successors, each year, preferably including the June issue, a statement regarding the Lamme Medal and an invitation for any member to present to the Secretary of the Institute by December 1, the name of a member as a nominee for the medal, accompanied by a statement of his 'meritorious achievement' and the names of at least three engineers of standing who are familiar with the achievement."

Each nomination should give concisely the specific grounds upon which the award is proposed, and also a complete detailed statement of the achievements of the nominee, to enable the committee to determine its significance as compared with the achievements of other nominees. If the work of the nominee has been of a somewhat general character in co-operation with others, specific information should be given regarding his individual contributions. Names of endorsers should be given as specified in the foregoing quotation.

Article V, section 2, specifies that:

"The committee in making the award shall carefully observe the limitation imposed by Mr. Lamme, that the recipient must have 'shown meritorious achievement in the development of electrical apparatus and machinery.' This shall be taken to mean that the meritorious achievement must be of such character that it has resulted or will result in the production of substantially improved electrical apparatus or machinery. Any work which meets this requirement is admissible whether it be (a) in development of the theory involved; (b) in development of the characteristics of the materials employed; (c) in development of over-all design; or (d) in development in other ways which results in substantial improvment in electrical apparatus or machinery. The words 'electrical apparatus or machinery' shall be taken to indicate discrete and self-contained devices which may or may not include mechanical moving parts without limitation as to the field of application. They shall not be taken to include transmission or distribution systems as a whole, but rather to include the apparatus and machinery that is used in making up such systems."

attendance at all events without conflict. This unique "package" of meetings will attract important engineers and scientists from most countries of the world.

The meetings and dates are:

September 3-6, 1958, Montreal, Que., Canada—Fifth Convention of the Pan American Federation of Engineering Societies (UPADI).

September 7-11, 1958, Montreal, Que., Canada—Canadian Sectional Meeting of the World Power Conference.

September 11-14, 1958—Joint Study Tour (sponsored by the Canadian National Committee of the World Power Conference and the United States Committee on Large Dams) to St. Lawrence River Navigation and Power Projects, to Niagara Falls, to the Nuclear Power Station at Shippingport, and to New York City.

September 15-20, 1958, New York, N.Y., Hotel Statler—Sixth International Congress on Large Dams.

Additional information is contained in the General Program of the Canadian Sectional Meeting of the World Power Conference, available from the Canadian National Committee of the World Power Conference, Room 500, 150 Wellington St., Ottawa 4, Canada; and in Bulletin No. 2, issued by the U. S. Committee on Large Dams, c/o Engineers Joint Council, 29 W. 39th St., New York 18, N.Y.

Thos. Cook & Son will be the official travel agent for the Post-Congress Study Tours (September 21-28, 1958) following the Sixth International Congress on Large Dams, and also for New York City arrangements.

Officers Elected for 1959 National Electrical Week

N. J. MacDonald, president of The Thomas & Betts Co., Elizabeth, N. J., was elected chairman of the National Electrical Week (NEW) Committee at the committee's semiannual meeting in Chicago, Ill., recently.

He succeeds M. E. Skinner, vice-president and director of sales of Union Electric Co., St. Louis, who has led the development of NEW as an all-industry event for the past three years.

The committee reviewed reports on the 1958 observance of NEW, elected officers, and approved preliminary plans for the next annual observance, scheduled for February 8-14, 1959.

Other NEW committee officers elected include Col. S. R. Todd, past president of International Association of Electrical Inspectors (IAEI), as vice-chairman; A. W. Hooper, executive director of the National Association of Electrical Distributors, as secretary; and H. A. Webster, president of T. Frederick Jackson, Inc., as treasurer.

NEW is held each year during the week of Thomas A. Edison's birthday. The national committee represents the following sponsor organizations: Air-Conditioning and Refrigeration Institute, American Home Lighting Institute, Edison Electric Institute, IAEI, International Association of Electrical Leagues, International Brotherhood of Electrical Workers, National Appliance and Radio-TV Dealers Association, National Association of Electrical Distributors, National Electrical Contractors Association, National Electrical Manufacturers Association, National Industrial Service Association.

It is also endorsed by the following: AIEE, American Farm Bureau Federation, American Home Laundry Manufacturers Association, American Society of Agricultural Engineers, Canadian Electrical Council, Canadian Section of IAEI, Electronic Parts and Equipment Manufacturers, Illuminating Engineering Society, Inter-Industry Farm Electric Utilization Council, International Association of Fire Chiefs, Inc., National Alliance of Television and Electronic Service Associations, National Association of Radio and Television Broadcasters, National Association of Television and Radio Farm Directors, Operation Home Improvement, and The National Grange.

Plans Made for National Power Conference

The first combined National Power Conference to be sponsored by AIEE and The American Society of Mechanical Engineers (ASME) is scheduled for Boston, Mass., September 29-October 1, 1958.

Since the general Conference plan of not having concurrent sessions was agreed upon, the problem arose of covering both the mechanical and electrical areas sufficiently to make the Conference worthwhile, with only six technical sessions. By adopting the "reporter" type of presentation for certain subjects a much broader coverage will be possible. This method has been used very successfully in Europe for some time and consists of a "reporter" giving a summary of a group of papers in approximately the time an author usually presents the resume of his paper. Following discussion of the group of papers, the author, or an author, of each paper will close that paper.

A decision was made to give those attending the Conference a maximum opportunity to participate in discussions, etc., by giving *each registrant*, at the time of registration a complete set of all papers that will be presented at the Conference.

A broad interesting program covering equipment, station design features, special application problems such as those in connection with supercritical units, etc., will be offered. There will also be a nuclear session, with one group of papers devoted to three or four plant designs with different types of reactors. The other group will be devoted to marine nuclear problems.

Petroleum Industry Conference Committee

MEMBERS of the 1958 Conference Committee met in Dallas, Texas, on April 2 to plan for the Petroleum Industry Conference to be held at The Baker Hotel in Dallas, September 15-17, 1958. They are: (*seated, from left to right*) J. L. Sandlin, secretary-treasurer; P. S. King, hospitality; L. E. Oberhelman, chairman, Petroleum Industry Committee; D. S. Coffman, chairman, Conference Committee; Mrs. M. A. Sullivan, ladies activities; C. A. Maas, technical program; D. N. Chadwick, vice-chairman, North Texas Chapter; (*standing, from left to right*) J. A. Savage, student activities; H. A. Soucy, registration; C. F. Crandell, registration; R. T. Martin, hospitality; Paul Neblett, vice-chairman, Conference Committee; J. B. Robuck, chairman, North Texas Chapter; Don Shimble, printing and programming; R. T. Shields, budget and finance; J. J. Cupples, publicity; Eldon Webb, inspection trips.

NEC Officers for 1958 Announced

J. H. Enenbach, supervising engineer at the Illinois Bell Telephone Company, has been elected president of the National Electronics Conference (NEC) for 1958.

Other officers named for the 1958 Conference—to be held October 13-15 at the Hotel Sherman in Chicago, Ill.—are: Executive Vice-President, M. H. Crothers, University of Illinois; Secretary, C. W. McMullen, Northwestern University; Treasurer, J. H. Kogen, Askania Regulator Company; Executive Secretary, R. E. Bard, General Radio Company; and Assistant Treasurer, G. J. Argall, DeVry Technical Institute.

The NEC, the nation's leading forum on electronic research, development, and application, has been held annually in Chicago since 1944.

It is sponsored by the AIEE, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern and Illinois Universities. Participants are Notre Dame, Purdue, Michigan State, Michigan, Wayne State and Wisconsin Universities, Electronic Industries Association, and the Society of Motion Picture and Television Engineers.

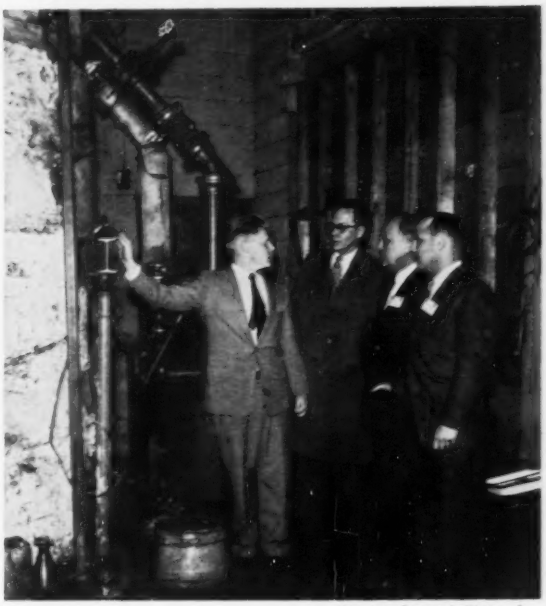
Committee chairmen for this year are: V. H. Disney, Armour Research Foundation, arrangements; J. A. M. Lyon, Northwestern University, awards; B. C. Hawkins, DeVry Institute, exhibits; J. D. Ryder, Michigan State University, finance; E. H. Schulz, Armour Research Foundation, fellowship; R. K. Masnaghetti, Purdue University, housing; W. R. Brock, Columbia Broadcasting System, NEC party; H. E. Ellithorn, University of Notre Dame, procedures; J. S. Aagaard, Northwestern University, proceedings; L. W. Von Tersch, Michigan State University, program; R. E. Hornacek, Illinois Bell Telephone Company, publicity; J. S. Brown, Andrew Corporation, registration; A. D. Bailey, University of Illinois, student activities; and C. E. Barthel, Jr., Armour Research Foundation, international activities.

It is expected that in 1958, a year of increasing importance to electronics, the Conference will be attended by 10,000 persons—mostly scientists, engineers, educators, manufacturers, Government officials, and students.

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

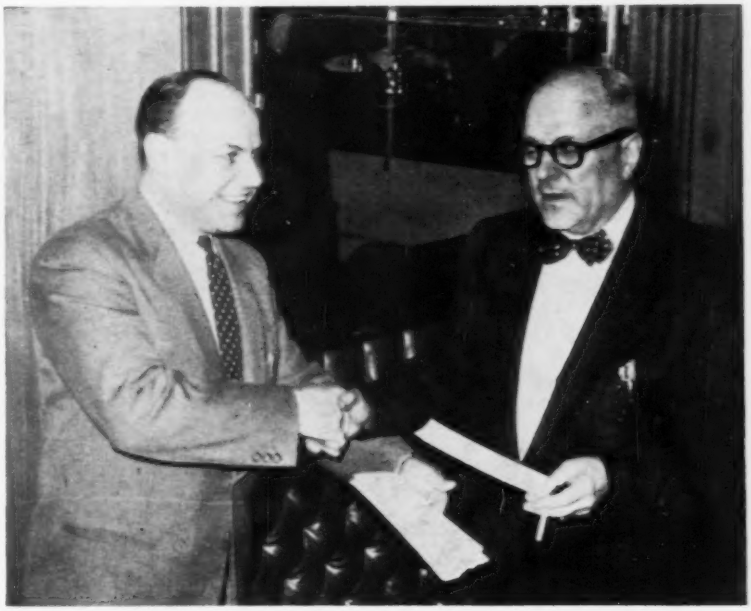
AIEE-ASME Management Conference



ENGINEERS inspect a fluid bed iron ore reduction pilot plant at The Arthur D. Little, Inc., Laboratories in Cambridge, Mass., during the AIEE-American Society of Mechanical Engineers (ASME) Engineering Management Conference, held in Boston, Mass., March 19-20, 1958, at the Hotel Somerset.

Courtesy Lenscraft Photos, Inc.

St. Maurice Valley Section



L. HEDIGER *(right)* of the Shawinigan Water and Power Company receives the St. Maurice Valley Section Prize Paper Award from W. G. Seline *(left)*, Section chairman. The award was presented at a March meeting of this first authorized AIEE Bilingual Section. The competition is the second since the Section was formed in 1954. Mr. Hediger's paper was entitled "Lightning Phenomena and Its Protection with Particular Reference to Present-Day Theories as Developed by Mr. J. Cougnard."

AIEE President Visits Cleveland Section

A MODEL of the new Cleveland Engineering and Scientific Center which is being constructed in Cleveland, Ohio, is inspected by *(left to right)* W. H. Chase, F. H. Knapp, AIEE President W. J. Barrett, and J. C. Strasbourger. President Barrett gave a short talk at the March 20 meeting of the Cleveland Section on the new United Engineering Center in New York City.

EJC Issues Annual Report for 1957

Part One of the Engineers Joint Council (EJC) Annual Report for 1957 opens with "The President's Report," a brief survey of EJC activities during the past year.

In his general summary, EJC President J. W. Barker discusses, among other matters, progress on plans for a comprehensive Survey of the Engineering Profession; co-operation with Engineers' Council for Professional Development in joint activities; and the AIEE plan, proposed as a step toward unification of the engineering profession.

Following "The President's Report" are reports by EJC Committees including those on Air Pollution, Constitution and Bylaws, Consulting Practice, Employment Conditions, Engineering Manpower Commission, Engineering Sciences, General Program, Governmental Activities, International Relations, Labor Legislation Panel, Membership, National Engineers Register, National Water Policy Panel—Review Board, Planning, Practice of Engineering, Public Relations, Recognition of Specialties in Engineering and Who's Who in Engineering.

Part Two of the Annual Report contains the constitution and bylaws; Part Three lists the committees for 1958; and Part Four includes a directory and the board of directors for 1958.

Session on Extra High Voltage

THE SPEAKERS AND OFFICERS of the Session on Extra High Voltage Systems, held during the 20th Meeting of the American Power Conference were *(left to right)*: E. T. B. Gross, Chicago, Ill., chairman of the session and chairman of the Electrical Program Committee; L. F. Lischer, Commonwealth Edison Company, Chicago; J. H. Hagenguth, General Electric Company, Pittsfield, Mass.; M. J. Lapoco, American Electric Power Service Corp., New York, N. Y.; G. V. Boll, Deutsche Verbund Gesellschaft, Heidelberg, Germany; and I. M. Robertson, co-chairman of the session, Public Service Company of Colorado, Denver.

1958 Nuclear Congress Preprints and Proceedings

There is still a complete stock of preprints for the Nuclear Engineering and Science Conference and the proceedings of the Hot Laboratories and Equipment Conference from the 1958 Nuclear Congress held at the Chicago, Ill., International Amphitheatre, March 17-21, 1958. Publication of the transactions of this Conference in one volume is not planned.

As the preprints and proceedings will not be reordered, it is suggested that those planning to purchase copies do so at once to avoid disappointment.

The proceedings of the Hot Laboratories and Equipment Conference sell for $10 per bound volume. The preprints sell for 50¢ per copy. Order by number from: American Institute of Chemical Engineers, 25 W. 45th St., New York 36, N. Y. See March 1958 issue of *Electrical Engineering*, pp. 258-62, for order coupon and for list of papers available. The following papers, not announced at the time the Nuclear Engineering and Science Conference program was published in *Electrical Engineering*, are also available.

170 Chromium-51 Plated Rings for Use in Wear Studies. *C. H. Wright*, U. S. Radium Corporation

171 Radioactive Chromium as a Tracer Aid in the Determination of Wear of Automotive Piston Rings in Vehicle Operation. *R. G. Abowd, Jr.*, Ethyl Corporation Research Laboratories

183 Operation of 3,000-GPM Sodium Pumps. *C. E. Miller*, General Electric Company

189 Design of the Reactor Piping and Pressure Tubes for the PRPR. *J. C. Fox*, General Electric Company

197 High Pressure Control Rod Actuator. *Charles Linnert*, American Machine & Foundry Company

201 Shock Analysis of Pressurized Water Reactor Core Suspension Systems. *A. J. Martenson, J. S. Busch, C. F. Peck*, Westinghouse Electric Corporation

200 Leak Tightness Inspection of Nuclear Power Plants and Their Components. *D. J. Santeler*, General Electric Company

214 Advancing Nuclear Component Design by a Construction Code. *J. F. Harvey, R. M. Douglass*, The Babcock and Wilcox Company

198 Comparison of Activation Analysis and Danger Coefficient Analysis. *M. R. Gustavson, S. Kahn*, Aerojet-General Nucleonics

180 A Reactor Source for Space or Process Heat. *W. L. Ross*, American Standard

181 The Market for Industrial Heat Reactors. *K. M. Mayer*, Nuclear Products-Erco, A.C.F. Industries, Inc.

190 A Novel Control Rod Actuator for Nuclear Reactors. *Dominic Scotto, Daniel Mager*, American Bosch Arma Corporation

204 Design Problems of Specialized Core Components of the PRP Reactor. *D. J. Foley*, General Electric Company

192 Early Operating and Maintenance Experience with the Army Package Power Reactor. *J. W. Barnett, E. E. Daly, J. D. LaFleur, Jr.*, U.S. Army Engineer Research & Development Laboratories, Fort Belvoir, Va.

184 Cleaning Nuclear Reactor Systems.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

A. L. Medin, R. J. Clark, Alco Products, Inc.

182 A Process for Improving the Chemical Characteristics of Uranium Oxides. *W. R. De Hollander,* General Electric Company

193 The Zirconium-Uranium Dioxide Reaction. *A. F. Gerds, J. W. Droege, M. M. Mallett, A. W. Lemon, Jr.,* Battelle Memorial Institute

203 Program in Design of the Yankee Atomic Plant. *G. A. Reed,* Yankee Atomic Electric Company; *W. C. Woodman,* Stone and Webster Engineering Corporation; *W. E. Abbott,* Westinghouse Electric Corporation; *J. F. A. Longeor,* Stone and Webster

172 Kinetics of the Beta Transformation of Uranium. *W. R. McDonnell,* Savannah River Laboratory

178 Dimensionally Stable Uranium Alloys. *A. L. Eiss, H. S. Kalish,* Sylvania-Corning Nuclear Corporation

217 Techniques for Maintaining Water Purity in Nuclear Reactor Recycling Water Systems. *W. L. Sibbitt, W. J. Rudy,* Los Alamos Scientific Laboratory

199 Induced Photoconductivity in Cadmium Sulfide for Nuclear Radiation Detection. *L. E. Hollander, Jr.,* American-Standard Atomic Energy Division

207 Nuclear Characteristics of Thermal Power Reactors. *O. J. Woodruff, Jr., M. J. Galper, R. T. Bayard,* Westinghouse Electric Corporation

176 The Role of the Experimental Reactor in the Plutonium Recycle Program. *R. M. Fryar,* General Electric Company

213 Vallecitos Boiling Water Reactor. *L. Kornblith, Jr., S. Untermeyer, L. Welsh, W. H. Nutting,* General Electric Company

205 A Simple Temperature Regulating Means for Irradiation Experiments. *C. V. Moore,* General Electric Company

185 Tracer Studies of Tidal Estuary Models. *P. J. Huisvaard, R. B. Banks, C. G. Bell,* Northwestern University

174 Main Coolant Instrumentation for High Performance Pressurized Water Reactor Power Plants. *L. C. Noyes,* General Electric Company

31 A Study of Aluminum-Uranium Alloys Containing up to 45 w/o Uranium. *N. E. Daniel, E. L. Foster, R. F. Dickerson,* Battelle Memorial Institute

179 Steady-State Performance of a Thermal Circulation Loop Containing a Parallel Path Heat Sink. *J. J. Foster,* General Electric Company

202 Internal Hydraulic Effects Resulting from Mechanical Shock of a Reactor Vessel. *A. S. Weinstein, C. F. Zorowski,* Carnegie Institute of Technology

175 Reactor Power Calculator. *J. W. Adams,* E. I. du Pont de Nemours & Co. (Inc.)

188 Engineering Approaches to Some Materials Problems of Nuclear Power Plants. *W. L. Fleischmann, S. L. Williams*

194 Corrosion Studies in Organic Heat Exchange Media. *W. K. Boyd, G. L. Ericson, O. M. Stewart, P. D. Miller,* Battelle Memorial Institute

169 Some Methods for the Determination of Radionuclides in Water in Low Concentrations. *B. Kahn, S. A. Reynolds,* Oak Ridge National Laboratory

191 The Movement of Strontium-90, Cesium-137, and Plutonium-239 through Tuff Local to the Los Alamos, N. M., Area. *C. W. Christenson, E. B. Fowler, G. L. Johnson, E. H. Rex, F. A. Vigil,* Los Alamos Scientific Laboratory

173 Development of a Wafer-Type Fuel Element for the Experimental Breeder II. *S. I. Megeff, F. E. Bowman, H. S. Kalish,* Sylvania-Corning Nuclear Corporation

220 The Design of Irradiation Loops. *Robert Gordon,* Aerojet-General Nucleonics

206 Controlled Bowing of Fuel Subassemblies. *R. E. Petersen,* Franklin Institute Laboratories

208 Nuclear Fuels Inspection Techniques. *R. O. Hutchison,* American Machine and Foundry Company

210 X-Ray Inspection of Highly Radioactive Nuclear Fuel Elements. *W. M. Barss,* Atomic Energy of Canada Limited

187 General Electric Test Reactor Plant and Facilities. *E. R. Craig, M. J. Larocco, W. S. Prince,* General Electric Company

212 A Reactor for the Irradiation of Large Equipment Components and Assemblies. *T. J. Pashos, H. M. Bass*

177 Two Thermodynamic Systems for Molten Fluoride Reactors. *B. W. Kinyon, F. E. Romie,* Oak Ridge National Laboratory

186 Steady-State Part-Load Characteristics of a Sodium-Heated Steam Plant. *W. T. Morgan, J. E. Mahlmeister, L. R. Blue,* North American Aviation, Inc.

168 Kinetic Effects in the Partitioning of Uranium and Plutonium in the Processing of Irradiated Reactor Fuels by Extraction with Tributyl Phosphate. *W. W. Morgan, W. G. Mathers, R. G. Hart,* Atomic Energy of Canada, Ltd.

221 Design Aspects of Embedded Reactor Shells. *S. H. Fistedis, H. O. Monson,* Argonne National Laboratory

A. H. Kidder Addresses MSPE Meeting

DR. G. C. GARLAND, director of admissions at Northeastern University (*right*), congratulates A. H. Kidder (F '50), Northeast Regional vice-president of the National Society of Professional Engineers (*left*), after Mr. Kidder's speech before the Massachusetts Society of Professional Engineers' (MSPE) Annual Meeting recently held at Babson Institute of Business Administration. Looking on (*center*) is A. G. Karol of MIT.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until June 26. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 west 39th St., New York 18, N. Y., on or before June 26.

57-503 **Design Considerations for Aircraft Relays.** *L. E. Massie, E. F. Kotnik*

57-701 **Spectrum Analysis of Random-Noise Generators.** *L. G. Polimerou*

57-1020 **Automatic Mobile Telephone System.** *R. P. Dimmer*

57-1028 **The Diode Reactance Modulator.** *G. F. Montgomery*

57-1159 **Diversity of Farm Loads.** *L. B. Altman, Jr., L. F. Charity*

58-105 **The Technique and Instrumentation of Low-Impedance Ground Measurement.** *C. A. Duke, L. E. Smith*

Reprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

Travel Grants Provided by NSF

The National Science Foundation (NSF) is authorized to provide a limited number of travel grants to assist qualified physical scientists, mathematicians, and engineers who wish support to attend international meetings concerned with subjects in the physical sciences.

Applications for financial support should be submitted prior to June 30 for travel between October 1, 1958, and March 31, 1959. And applications must be received before December 31 for travel to be performed between April 1, 1959, and September 30, 1959.

Requests for applications should be addressed to the Assistant Director for Mathematical, Physical, and Engineering Sciences, National Science Foundation, Washington 25, D. C.

AIEE FELLOWS ELECTED

Board of Directors Meeting, February 7, 1958

William Fremont Dunkle (AM '24, M '47), chief of electrical tests, Pennsylvania Power & Light Co., Hazleton, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electrical system testing techniques particularly in the field of dielectrics." Mr. Dunkle was born in Beech Creek, Pa., October 17, 1896. He received the degree of E.E. from the University of Cincinnati under its co-operative system in 1923. He interrupted his education to volunteer for service in the U.S. Army where he received a commission. Following graduation and employment with Union Gas & Electric Co. of Cincinnati, he accepted employment with Pennsylvania Power & Light Co. in 1924, where he became chief of electrical tests in 1927. Mr. Dunkle has developed policies, methods, schedules, and test equipment putting electrical testing on a production basis. His research has been in the field of insulation quality control and instrumentation for evaluating ground systems. Mr. Dunkle has served on all Lehigh Valley Section Committees and currently is the Section chairman. He was chairman of District No. 2 Prize Paper Committee, 1953, and vice-chairman of District No. 2 Meetings and Papers in 1954. A member of the Dielectric Tests Subcommittee and Measurements on Dielectrics Subcommittee, he is chairman of two working groups, one of which has developed insulation power factor test codes for mineral oil-immersed transformers, and the other currently is developing performance requirements for bushings 25 through 230 kv. He has been an active member of the American Standards Association C57 Subcommittee for power and distribution since 1951. He has presented numerous papers on insulation quality control to the Lehigh Valley Section, Pennsylvania Electric Association, and Doble Client Conference, and also is the author of three Transactions papers. He is a registered professional engineer in the State of Pennsylvania and a member of Eta Kappa Nu.

Ingolf Berger Johnson (AM '40, M '45), manager, power systems engineering, Analytical Engineering Sections, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for leadership and contributions in the field of electric power system protection." Mr. Johnson was born in Brooklyn, N. Y., September 29, 1913. He received the B.S. degree in E.E. in 1937 and the M.S. degree in E.E. in 1939, both from the Polytechnic Institute of Brooklyn. In 1939, he joined the General Electric Company as a test engineer. He was employed as laboratory engineer in the High Voltage Laboratory from 1940 to 1942; design engineer of distribution transformers, 1942 to 1943; development engineer of aircraft ignition systems, 1943 to 1945; and analytical application engineer from 1945 to 1950. In 1950, Mr. Johnson became manager of power systems engineering of the Analytical Engineering Section. Mr. Johnson is a member of Eta Kappa Nu, Tau Beta Pi, the Polytechnic Alumni Association, Schenectady General Electric Engineers Association, and Conference Internationale des Grands Reseaux Electriques. The author of about 30 technical papers, he received first prize in the AIEE Power Division, 1955-56, as co-author of the paper "Switching Surges and Arrester Performance of High-Voltage Systems." Mr. Titus is a member of the AIEE Transmission and Distribution Committee (1953-58) of which he is the present chairman. He is a member of the Power Division Committee (1957-58) and is also serving on the General Systems Subcommittee, Lightning Protective Devices Subcommittee, Working Group on Multi-Line Station Protection, Working Group on Switching Surges, and Working Group on Surge Transfer through Transformers.

Fremont Lee Roe (AM '19, M '28), staff consultant, engineering department, Salt River Power District, Phoenix, Ariz., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electric power system development in pioneer territory." Mr. Roe was born in Indianapolis, Ind., April 13, 1898. He received his degree in electrical engineering from the Milwaukee School of Engineering in 1916. He served for a year with the Wisconsin Gas and Electric Company before enlisting in the First Wisconsin Cavalry in 1917. In 1919, he began service with the Salt River Valley Water Users' Association as a maintenance electrician at Roosevelt Dam Power Plant. In 1921, he was transferred to the main office in Phoenix as an office engineer in the Power and Pumping Division. In 1924, he became transmission and distribution engineer and in 1932 he was promoted to superintendent of the Power and Pumping Division of the Salt River Project. He became chief engineer in 1947 and staff engineer in 1948. This title was changed to staff consultant in 1953, and in this position he is a general system consultant for engineering, system planning, relaying, operations, and construction. Mr. Roe is a registered professional engineer in the State of Arizona. He has been active in the Arizona Section of the Institute working on committees and encouraging young engineers to join and support the local Section. During his 41-year career Mr. Roe's engineering abilities have been applied to practically every field of power engineering, motor load problems, distribution, subtransmission, transmission, relaying, power plant design and system operation. His contributions to the Salt River Project have played no small part in the success of this organization which is one of the first reclamation projects under the original U.S. Reclamation Service, now the U.S. Bureau of Reclamation.

Victor E. Schlossberg (AM '29, M '35) assistant general manager, operating services, Inland Steel Co., East Chicago, Ind., has been transferred to the grade of Fellow in the AIEE ". . . for engineering and administrative leadership in a large steel company." Mr. Schlossberg was born in New York, N. Y., on May 28, 1905. He received the B.S. degree in E.E. in 1926 and the E.E. degree in 1933, both from Rose Polytechnic Institute. Mr. Schlossberg's entire engineering and management career has been with the Inland Steel Co., where he started as a test engineer upon graduation. He has since held various positions and, in his present position as assistant general manager in charge of operating services, he is directly responsible for the functions of the electrical, engineering, field serv

W. F. Dunkle

I. B. Johnson

F. L. Roe

Warren Kay Fantine

V. E. Schlossberg

C. H. Titus

ices, mason, mechanical, power, steam, combustion, traffic, transportation, and yard departments. During his career, he has contributed greatly to the advancement of electrical applications relating to steel plants. He was on leave in 1945 to serve as research analyst with the rank of Colonel, U. S. Strategic Bombing Survey. Mr. Schlossberg is a registered professional electrical and mechanical engineer in the State of Indiana. He is a member, past district chairman, and past national director of the Association of Iron and Steel Engineers (AISE), and he holds memberships in the National Society of Professional Engineers, Western Society of Engineers, Electrical Maintenance Engineers, American Iron and Steel Institute, Blast Furnace and Coke Plant Association, and Tau Beta Pi. Mr. Schlossberg served on the AIEE Rotating Machinery Committee (1949-51) and on the Insulation Resistance Subcommittee. He was chairman of the Joint National Electrical Manufacturers Association-AISE Committee on Mill Brake Standardization.

Charles Hoff Titus (AM '40, M '47), manager—engineering, Engineering Research and Development Laboratory, laboratories department, Switchgear and Control Division, General Electric Company, Philadelphia, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to design and development of industrial and high voltage circuit interrupting devices." Mr. Titus was born in Middletown, Pa., on December 13, 1916. He received a B.S. degree in E.E. in 1938 and an M.S. degree in E.E. in 1940, both from Lehigh University. In 1940, he joined the General Electric Company as a student engineer. In 1941, he was assigned to the air circuit breaker department as a design engineer; in 1943, he assumed duties as an application and development engineer in the same department. From 1947 until 1951, he was working as assistant engineer of the Switchgear Laboratory. In 1951, he assumed the duties of manager, advance engineering section, laboratories department. In 1954, he was made manager, advance engineering subsection, low voltage switchgear department. In September 1956, he was named to his present position as manager—engineering, Engineering Research and Development Laboratory. Mr. Titus is the author of several technical papers and a number of patents have been granted him on electromechanical devices. He is a registered professional engineer in the State of Pennsylvania and is also an associate member of the Institute of Radio Engineers.

AIEE PERSONALITIES

J. T. Madill (AM '41, M '48), manager of power operations, B. C., of Aluminum Company of Canada, Ltd., has been transferred from Kitimat, B. C., to Montreal, Que., where he will be assistant general manager, Power Division Operations, for Alcan. Mr. Madill is a member of the AIEE Power Generation Committee (1947-58) and Chemical Industry Committee (1955-58).

A. J. Warner (M '45), of the International Telephone & Telegraph Corporation, has joined DeBell & Richardson, Inc., consulting engineers in the plastics field, at Hazardville, Conn., as an insulating and semiconductor consultant to the electrical and electronics industries. Mr. Warner served on the AIEE Special Communication Applications Committee (1949-51) and Insulated Conductors Committee (1951-54).

Morris Brenner (AM '46, M '54), chief engineer, Penn-Union Electric Corporation, Erie, Pa., has been appointed as vice-president, engineering.

J. C. Strasbourger (AM '31, M '40), of the Cleveland Electric Illuminating Company, has joined the organizations of Muncie Engineering, Inc., Mitchell Maintenance Co., Inc., Lift-A-Loft Company, as executive vice-president. Mr. Strasbourger is a former vice-president of AIEE District No. 2 (1951-53) and has served on the following Institute Committees: Planning and Co-ordination (1946-49, 1954-57); Sections (1947-50, 1951-55, chairman 1947-49); Award of Institute Prizes (1948-49); Safety (1950-51); Executive (1957-58); and Finance (1957-58). He was chairman of the AIEE Administration Department (1956-57), and is a member of the AIEE Board of Directors (1956-61).

C. L. Killgore (AM '37, M '47), assistant chief designing engineer for electrical and mechanical work in the U. S. Bureau of Reclamation, is president of the new consulting firm of Engineering Consultants, Inc., Denver, Colo. Mr. Killgore has served on several AIEE Committees including the Swithgear Committee and Systems Engineering Committee. **W. H. Hinch** (AM '42, M '48), supervisory electrical engineer with the Bureau of Reclamation, has been made treasurer of the firm. Engineering Consultants, Inc., and Sverdrup & Parcel International, Inc., have been appointed as consultants for the $100 million Yanhee Hydroelectric Project in central Thailand.

G. E. Hertig (AM '51), equipment and application engineer with Commonwealth Associates, Inc., has been appointed substation application engineer for the R&IE Equipment Division of I-T-E Circuit Breaker Company, Greensburg, Pa.

D. R. Hull (M '48), vice-president and general manager of equipment operations, Raytheon Manufacturing Company, Waltham, Mass., has been appointed vice-president for defense programs of the company.

W. H. Davis (AM '50), regional representative, Allis-Chalmers Manufacturing Company Central Region Office, Cleveland, Ohio, has been appointed manager of product sales, electrical department, at Allis-Chalmers Norwood (Ohio) Works.

W. P. Fralia (AM '51), sales engineer, Texas Electric Service Co., is the new sales manager of Lone Star Plastics Co., Inc., Fort Worth, Texas.

W. E. Sutter (AM '55), district microwave sales manager for the General Electric Company (GE) at Redwood City, Calif., has been appointed national manager of microwave sales for GE's communication products department with headquarters in Syracuse, N. Y.

A. L. Stegner (AM '41), corrosion engineer for Tennessee Gas Transmission Company, Houston, Texas, has been re-elected for a second term as treasurer of the National Association of Corrosion Engineers.

F. J. Schneider (AM '41), general superintendent of operations for the Central Division, Niagara Mohawk Power Corporation, has been appointed to a similar position in the Western Division with headquarters at Buffalo (N. Y.) to succeed **C. H. Anderson** (M '34) who has transferred to Syracuse (N. Y.) as system supervisor of division construction.

E. C. Duffy (M '50), vice-president responsible for engineering, construction, and electric and gas operations, Long Island Lighting Company, Mineola, N. Y., has

been elected a senior vice-president. **William Welch, Jr.** (M '53), assistant vice-president, was elected vice-president.

C. W. Bernhard (AM '45), assistant to the manager of the motor and generator department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been appointed assistant to the chief engineer, steam turbine department.

R. C. Dickinson (AM '37, F '48), section engineering manager in charge of the design of magnetic type air circuit breakers, Westinghouse Electric Corporation, and **R. E. Frink** (AM '55), supervising engineer in the same section, received a $10,000 patent award from Westinghouse in recognition of their inventions that greatly improved protection devices for electrical distribution systems.

G. L. Haller (M '45), general manager of the General Electric Company's Defense Electronics Division, Electronics Park, Syracuse, N.Y., has been elected a vice-president of the company.

Herbert Harris, Jr. (AM '46), chief engineer of Sperry Gyroscope Company's Air Armament Division, Great Neck, N. Y., has been appointed manager of the division.

B. L. Arnold (M '50), sales manager, and **W. G. McElfresh** (AM '56), senior sales engineering representative, Lenkurt Electric Company, have both been assigned to the firm's Engineer, Furnish, and Install Group.

E. H. Krieg (M '47), vice-president and consulting engineer of Stone & Webster Engineering Corporation, New York, N. Y., has been elected a director. Mr. Krieg served on the AIEE Nucleonics Committee (1947-50).

L. L. Lind, Jr. (AM '40, M '47), principal electrical engineer in Ebasco Services, Inc.'s Design and Construction Division, has been appointed special assistant to R. W. Johnson, director, Advance Research Projects Agency, Department of Defense, an agency recently established to meet the needs of the United States space conquest program.

Jerome Ottmar (AM '49), vice-president, Metals & Controls Corporation, Attleboro, Mass., has been elected chairman of the Electrical Contacts Section of the National Electrical Manufacturers Association.

D. C. Pinkerton (M '51), consulting engineer at the General Electric Company's Electronics Laboratory, Syracuse, N. Y., has been appointed manager of advance engineering of the communication products department. Mr. Pinkerton has served on the AIEE Carrier Current Committee (1951-55) and Radio Communications System Committee (1956-58).

H. H. Sheppard (AM '34, M '51), has been elected vice-president and manager of the electrical equipment department of the Rumsey Electric Company, Philadelphia, Pa. Mr. Sheppard has served as chairman of the Philadelphia Section of the Institute and is presently chairman of the AIEE Sections Committee. He is also a member of the Public Relations Committee and the Administration Department.

O. W. Sommers (M '46), assistant general manager of the City Public Service Board, San Antonio, Texas, has been appointed general manager to succeed **V. H. Braunig** (AM '30, F '57), who was retained as engineering and management consultant. **J. E. Sheehan** (M '28, F '33), staff engineer in the executive department of the City Public Service Board, was promoted to executive assistant to the general manager.

H. E. Way (AM '23, M '26), industrial specialist and assistant to the director, Electrical Equipment Division of the Business and Defense Services Administration, U. S. Department of Commerce, received the Meritorious Service Award from Secretary Sinclair Weeks at a ceremony on February 12, 1958.

T. R. Welch (AM '46, M '53), formerly director of research and development for Elgin Watch Company's Electronics Division, Burbank, Calif., has been named general manager of TC Components Division of Brubaker Electronics Company, a subsidiary of Telecomputing Corporation, Los Angeles, Calif.

R. W. Burtness (AM '54), member of the research staff, Stewart-Warner Electronics, a division of Stewart-Warner Corporation, Chicago, Ill., has been appointed manager of engineering and research.

V. J. Cozzarin (AM '45, M '52), manager of the Cleveland, Ohio, repair plant of the Westinghouse Electric Corporation, has been named manager of the Cincinnati, Ohio, manufacturing and repair plant. **A. C. Del Col** (AM '50, M '52), superintendent of the Cleveland plant, succeeds Mr. Cozzarin as manager.

F. G. Goldner (AM '55), design engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed product development engineer for the Hi-Line Hardware Division of the Brewer-Titchener Corporation, Cortland, N. Y.

W. J. Plate (AM '51), electrical engineer, Anaconda Wire & Cable Company, Hastings on Hudson, N. Y., has been appointed to the position of manager of the Accessories Division.

F. A. Hubbard (AM '41), superintendent of electric operations, New Bedford Gas and Edison Light Company, has been appointed general superintendent.

D. G. DeBolt (AM '50), sales engineer, A. B. Chance Company, Centralia, Mo., has been appointed product manager, power-switching equipment.

C. D. Dimity (AM '40, M '42), manager, utility sales, and **E. F. Gordon** (AM '45), sales department, Phelps Dodge Copper Products Corporation, have both been elected assistant vice-presidents.

R. E. Greene (AM '26 M '46), assistant manager of construction for the Detroit Edison Company, retired recently after nearly 32 years of service with the company. Mr. Greene served on the AIEE Power Generation Committee (1935-36).

H. G. Blumberg (AM '42), executive vice president of the Ferguson Electronic Supply Co., Detroit, Mich., has been elected president of the National Electronics Distributors Association, Michigan Chapter.

T. A. Combellick (AM '56), of Lenkurt Electric Company's Military Division, has been promoted to manager of its Washington, D. C., office and director of the eastern area Government sales.

J. M. Morgan (AM '22, M '30), of Washington, D. C., has been appointed by the United Nations to the position of American Representative for the Economic Commission for Asia and the Far East with headquarters in Bangkok, Thailand. His territory will extend from Japan to the Philippines, where he will recommend projects to the Bureau of Flood Control and Water Resource Developments on the various countries in his territory. Mr. Morgan serves on the AIEE Industrial Control Committee (1952-58).

OBITUARIES

Ray Clinton Faught (AM '19, Member for Life), retired engineer of the General Electric Company, Baltimore, Md., died recently. Mr. Faught was born in Sidney, Maine, on January 22, 1875. After graduating from the Massachusetts Institute of Technology in 1898, he joined the General Electric Company.

Morland King (AM '06, F '25, Member for Life), professor of electrical engineering and for many years head of the electrical engineering department at Lafayette College, Easton, Pa., died recently. Prof. King was born in Brooklyn, N. Y., on November 22, 1881. He received the B.E. degree in E.E. in 1905 and the M.E.E. degree in 1906, both from Union College. He was a member of the electrical engineering faculty at Union until 1920 when he became associate professor of electrical engineering at Lafayette College. He was made professor and head of the electrical engineering department in 1921. Prof. King was a registered professional engineer in the State of Pennsylvania, a member of the American Association of University Professors, American Society for Engineering Education, Tau Beta Pi, and Sigma Xi.

George David Young Leacock (M '40), president of Moloney Electric Company of Canada, Ltd., from 1922-56, died recently in Toronto, Ont., Canada. Born on a farm near Toronto, Mr. Leacock joined the Canadian Company of Moloney Electric Company of St. Louis in 1913 as the Toronto district manager. He later became sales manager and was made president in 1922. Mr. Leacock was a member of the Professional Engineers of Ontario and many other organizations.

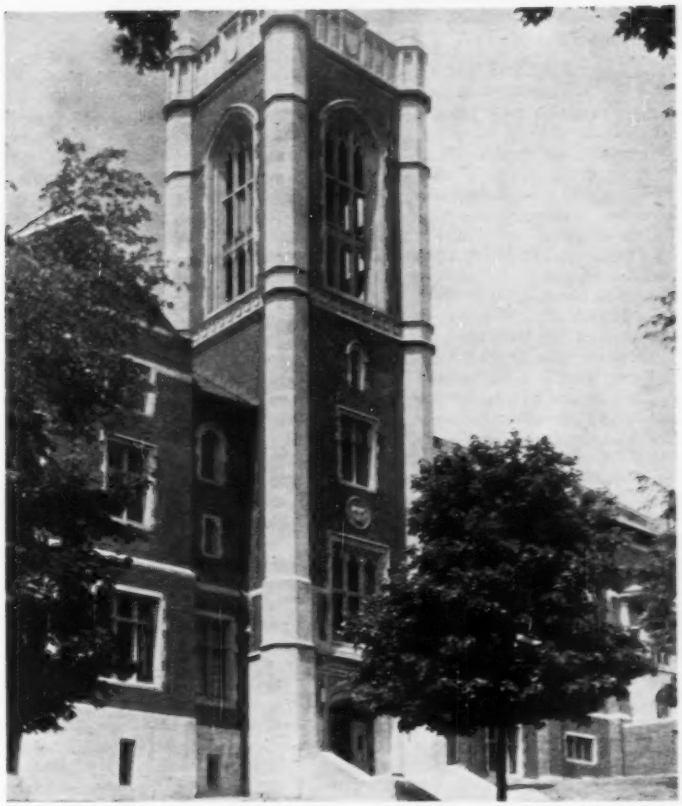
ELECTRICAL ENGINEERING EDUCATION

AIEE in Worcester Polytechnic Institute

THE ELECTRICAL ENGINEERING DEPARTMENT at the Worcester Polytechnic Institute, Worcester, Mass., was established in 1893, 30 years after the founding of this engineering college. The Student Branch of the AIEE received its charter on October 14, 1925. Present Branch counselor is W. R. Grogan.

As one of the six degree granting departments in science and engineering, the electrical department is staffed by 14 full-time faculty members and 6 graduate assistants. Over 100 of the students are members of the AIEE.

Alden Memorial (*right*) is one of the 15 buildings located on the Worcester Polytechnic Institute campus.



Technical Education and Research in India

M. G. MALTI
MEMBER AIEE

MY KNOWLEDGE of technical education in India[1] was acquired through a two-year (1955-57) tour of duty at the University of Roorkee, Roorkee, U. P., India, under a contract between Rensselaer Polytechnic Institute, Troy, N. Y., and the International Co-operation Administration, Washington, D. C.

During these two years, I lectured for periods varying from four days to four weeks at the following educational institutions: Indian Institute of Science, Bangalore, Mysore State; Birla College of Engineering, Pilani, Rajasthan State; M.B.M. College of Engineering, Jodhpur, Rajasthan State; and Bihar Institute of Technology, Sindri, Bihar State. While these are by no means the only technical institutions, they are certainly typical and afford a fairly good sample of engineering education in India.

It should be emphasized here that India is not a backward country. The University of Roorkee[2] is over 110 years old and counts among its alumni some of the most distinguished world authorities in civil engineering, particularly in irrigation and the development of water resources. Ever since India became independent, the number of Indian universities has almost doubled from 18 before independence (in August 1947) to 33 as of 1954, and the end is not yet in sight. The output of engineering graduates has risen from 1,000 before independence to 4,000 in 1954. Just before I left India, the universities were expanding their facilities to double this latter number by 1960.

Technical institutes were built, equipped, and put into operation within a short span of a few years. Among these are the Indian Institute of Technology at Karagpur, West Bengal State, which started functioning in 1952, Bihar Institute of Technology at Sindri, Bihar State, established a year later, and M.B.M. Engineering College a year later at Jodhpur, Rajasthan State.

There is no lack of leadership in education. Dr. A. N. Khosla, vice-chancellor of Roorkee University,* with whom I had the privilege of intimate association during my tour of duty in India, not only is an engineer of international reputation but also is a man of vision, an enthusiastic Indian patriot, a lover of the United States, and a highly efficient executive. Dr. Deshpande, principal of Bihar Institute of Technology, is the founder of that Institute. He cleared the ground of trees, planned and constructed the campus, selected teachers, and put it into operation.

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*The vice-chancellor in an Indian university corresponds to the president of an American university. The chancellor is the governor of the state in which the university is located.

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Professor Garde of M.B.M. College, Jodhpur, left his professorship at Roorkee University to found that College and, like Dr. Deshpande, built it from the ground up. Principal Lakshminarayanan, Birla College of Engineering, is another pioneer who planned that College and now supervises its activities. All these men and many others like them are a source of hope for the rapid and intelligent progress of engineering education in India.

India's constitution is similar to that of the United States'. India[1] has a Union Government (federal government), and 14 state governments, and 6 centrally administered areas. Educational institutions within a state (except the few private institutions) are generally supported partly by that state government and partly by the Union Government. Others, like the Indian Institute of Technology at Karagpur and several research institutes, are supported by the Union Government. Both the Union Government and the state governments have been generous in their support of education and research. The Union Government of India, in 1954, spent over 244 million rupees (about $50 million) on higher education. This constitutes 5% of the total expenditures of the Union Government. Converted into terms of our budget, this represents $3.5 billion which might have been appropriated for higher education by our Federal Government of which, alas, only about $280 million was spent in aid to higher education in the United States in 1954.

Finally, the Ministry of Education in the Union Government and the various ministries of education in the state governments are awake to the value of education in general and technical education in particular. These ministries are led by men some of whom I was privileged to know. They impressed me with their ability and their dedication to the service of their country.

We might, therefore, conclude that, on the whole, the outlook for technical education in India is very bright indeed. Let us now discuss the subject in great detail. For this purpose I would like to present my discussion under the following headings:

(1) Students seeking technical education
(2) Curricula
(3) General capability and availability of faculty personnel
(4) Equipment and library facilities
(5) Cost of technical education
(6) Opportunities for employment
(7) Research institutes

Students

Like all countries which have been recently liberated from foreign domination, India realizes that its future depends upon its industrialization. This realization is universal. Hence, it is easy to understand why, for every available student vacancy in technical schools, there exists anywhere between 20 and 30 applicants. In order to use the facilities of technical institutions to the best interest of the nation, Indian universities adopt the competitive entrance examination system. Sometime in the early Spring, the registrar of a university advertises in the newspapers the date and the place of the competitive examination and solicits applications from all those who wish to compete. The competitive examination covers the physical sciences, mathematics, and English. (English is at present the language used for all technical education in India.) The examinations are then corrected, the standing of the student is determined by the grade he makes, and the number of men who can be admitted (from 3% to 5% of those examined) is taken from those whose grades head the list.

This system of student selection results in a student body of high mentality. Unfortunately, it excludes students who, although not possessing the mental qualifications, have other desirable qualities for success and who could, perhaps, be picked if part of the examination was directed toward the discovery of such qualities in the prospective student. It is the author's opinion that some excellent material is lost to the Indian nation through this inequitable selection of the student body. It is doubtful, for example, if Gandhi or even Nehru would have been selected under such a system. Their outstanding quality of leadership would never have had the opportunity to reveal itself.

Despite its obvious defects, this selective system results in an excellent student body. The students are alert, responsive, and hard working. Moreover, unlike American universities, Indian universities do not suffer from a high rate of attrition. Thus, whereas in the United States some 60% of the freshmen graduate, almost 100% of the students entering Indian universities get their degrees or diplomas. Those who do not graduate fail because of economic or health reasons rather than scholastic inaptitude.

Another factor which contributes to better scholarship among university students in India is the absence of distractions. There are no weekly football games, no basketball games, no national or collegiate baseball games, no dates with girls, no fraternity activities, no television, a very slight amount of radio, very few magazines, and on the whole very little to distract a student from his studies. It is not the author's intention here to pronounce these distractions as positively harmful to the students. Indeed, it should be emphasized that extracurricular activities have a useful and vital place in the life of a student. They tend to develop qualities among our students which give them balance and maturity. However, some American students lay too much stress on these activities and too little on their scholarly pursuits. It is these students who fail in their work and contribute to the high rate of attrition in American universities. It must not be concluded from this that the university student in India does nothing but study. Games and sports are an integral part of every university. The students play tennis and squash. They have occasional football matches (Rugby type). They swim and even row boats. They have annual athletic meets which last a few hours. These sports, although encouraged by the universities, are neither highly organized nor are they income producing. There is no hero worship of athletes in Indian universities.

One important difference exists between the American student and the Indian student. Whereas the American student welcomes menial labor, the Indian student shuns it like the plague. The reason for this is that menial labor is done by a caste far inferior to that from which the student body is generally drawn. A student performing menial work automatically steps down to that lower caste. The caste system is quickly vanishing in India. Through the efforts of Gandhi, Nehru, and other leaders who recognize its faults, the caste system has been abolished by legislation. It is, however, not easy to abolish a custom thousands of years old on which the very structure of a society is built. Hence, wise administrators, such as the vice-chancellor of Roorkee University, have introduced "Shramdan" (voluntary labor) in order to give a practical application of these laws in Indian universities. Shramdan requires every Indian student to do voluntary menial labor as an extracurricular activity. One of the tangible results of Shramdan in the University of Roorkee is an addition to the Students' Club building which has doubled its floor capacity exclusively by student labor supervised by members of the faculty. Another students' project is a swimming pool designed according to Olympic specifications and constructed mainly by the students under Shramdan. A third project is an open-air theater and parking lot designed and constructed by the students under Shramdan. Each student spends an hour a day on Shramdan. Thus, a total of 1,200 student hours of voluntary labor are spent every day at the University of Roorkee or about 200,000 man-hours per academic year. New and useful Shramdan projects are created by the fertile mind of Dr. Khosla, vice-chancellor of the University, and are immediately put into effect by the student body under the supervision of the faculty.

Before leaving this subject of the student body, it is well to inquire what happens to the 95% of the applicants who are refused admission to a university because they failed to be among the top 5% of those who took the examination. Well, about 5% of these succeed in the examination for the diploma course. The remainder have no chance to become engineers. A few take examinations for less difficult professions (clerks, stenographers, and white collar workers); others seek government service as policemen, soldiers, railway employees, postal employees, etc.; and still others become tradesmen. Some are without jobs. It is this idle group of young men who are a great concern to the government and the community. One of the greatest problems which India faces today is to supply work for these idle young men.

Curricula

Unlike American universities, Indian universities offer varying courses. For the undergraduate student, there are diploma

courses and degree courses; and for the graduate student, there are refresher courses, and specialized courses leading to advanced degrees. Let us examine these courses in detail.

Diploma Courses. The diploma courses are intended to develop overseers, draftsmen, and other nonprofessional men who are associated with engineers. The emphasis in these courses is less on the theory and more on the practical aspects of engineering. In Roorkee University, associated with electrical engineering, there are diploma courses in drafting, in wiring, and in the care and repair of electric machines. Each course lasts for two academic years at the termination of which the successful student receives a diploma. Plans are under way to expand these courses to three years. Overseers are in great demand in India; hence, virtually all graduates are employed. A great deal could be done to improve the diploma courses through specialization. These courses would serve the needs of the country far better if their object were to turn out competent tradesmen, such as electricians, plumbers, mechanics, machine tool operators, tool and die makers, foundry men, carpenters, radio repair men, automobile mechanics, etc. Such tradesmen are extremely rare in India and their scarcity will retard materially the progress of India's industrialization.

It is my considered opinion that a thorough overhauling of these courses is absolutely essential if the needs of industrialized India are to be met. In the not too distant future India will find itself short of men who are thoroughly acquainted with modern tools and modern industrial techniques.

I should like to remark here that the Indians are extremely capable craftsmen. Their silk saris, their ivory and rosewood work, their inlays of ivory on wood or of silver on iron, their brass work, in fact all their handicraft reveal their excellent ability to execute detail and their infinite patience. It should be easy to train Indians in modern technical processes. In fact, there is every reason to expect that they have the talent and ability to become excellent tool and die makers and superior tradesmen.

Degree Courses. The degree courses in the better technical schools require four years. There are some universities, including Roorkee, which grant an engineering degree after three years of study. However, plans are under way to expand the training period in those universities to four years and thus make the engineering course a four-year course throughout India. One of my assignments was to revise the curriculum for electrical engineering at Roorkee University and extend it to four years. The revision was done with the co-operation of the faculty of electrical engineering at Roorkee after a series of 13 meetings during which free discussion took place.

Refresher Courses. These courses at Roorkee and other universities extend over periods of three months. The sequence in Roorkee is one period of three months in civil engineering followed by one period in electrical engineering, a period in civil engineering, and a period in mechanical engineering. Thus, four refresher courses are offered each calendar year, two in civil and one each in electrical and mechanical engineering. The teachers in these courses are drawn from the faculty as well as from specialists outside the university. Each three-month period is divided into two independent periods of six weeks each and the student has the choice of staying six weeks or three months as his circumstances require. These courses constitute an extra service rendered by the university to the public. The experiment is new in India and deserves the support of the government and private industry.

The students of these courses come from government departments and private industry. Their tuition and expenses are paid by the employer. They are mature and experienced engineers. Their ages range from 30 to 50. I had the privilege of teaching two refresher courses during my two years' stay in India and found the men eager, enthusiastic, and hard working.

Graduate Courses. When I was at Roorkee, there were no opportunities available for graduate study and research leading to the Ph.D. degree. The vice-chancellor appointed a committee and assigned to it the task of drafting rules and regulations for the Ph.D. degree. This committee held several meetings and emerged with regulations similar to those of any first class American university.

The master's degree is awarded for one year's residence involving course work and a project which requires a moderate degree of original thought.

The WRDTC. A new experiment[3] in education was started at Roorkee University to implement one of the decisions of the Bandung Conference of the Asian–African countries, namely "... in matters of technical aid, economic and cultural co-operation and exchange of experience, the countries of Asia and Africa will be reaching out to each other with the firm determination of benefiting by each other's experience on the basis of mutual co-operation viewed in the larger context of world co-operation." The Water Resources Development Training Center (WRDTC) at Roorkee University is an institute of advanced study in water resources and their use for irrigation, flood control, navigation, and electric power. Students who take this course must be graduate engineers with five years' engineering experience (officer engineers). The course covers such topics as river valley projects in India, Bhakra-Nangal Project, dams, mass concrete and its properties, concrete and masonry dams, laboratory aids to design, project investigation, treatment of foundations, flood control, design of power plants, earth dams, hydrology, and dimensional analysis. The teachers for these topics are seasoned specialists invited by the University for periods varying from a few days to a few weeks or months to lecture on their specialties. Specialists selected from among the faculty of the University also participate in this program. Finally, the University of Roorkee has the support of the Union Government of India which through the United States Technical Co-operation Mission and the International Co-operation Administration (ICA) sends specialists for this purpose. In addition to attending lectures, the students go on conducted tours to various dams, river valley projects, hydroelectric power plants, irrigation projects, and other water resources development centers in which India abounds.

The presence of Dr. Khosla, a world authority on the development of water resources, as the vice-chancellor and director as well as guiding genius of this experiment has added great prestige to WRDTC. This experiment in higher education has far-reaching possibilities and the university is sparing no effort to make it a success.

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Faculty

Although the buildings and equipment in a university can be erected and installed within a short period of one or two years, the faculty requires time to educate. Hence, we find the unhappy situation in India of an excellent student body confronted by an inexperienced, poorly trained, and poorly paid faculty. This must not be construed as a reflection on all the members of all the faculties of Indian universities. In my contacts with various educational institutions, I have come across some of the most capable and most experienced teachers. Indeed, some are brilliant, as witness Sir C. V. Raman, a Nobel Prize winner in physics. On the whole, however, the faculties in general are not as good as one would wish. The Government of India is alert to this problem. The Ministry of Education, during my last year in India, was studying the institution of a scholarship scheme whereby the Government would select a certain percentage of each graduating class for scholarship awards. The holders of these scholarships would then become graduate student–instructor–researchers in Indian universities. They would spend three years doing graduate work toward a masters degree, teaching under the guidance of capable professors, and doing research. After this period of training, they either would be assigned teaching posts in their field or allowed to pursue further graduate study, research, and teaching for another period of three years at the end of which they would be awarded the Ph.D. degree and assigned to a higher teaching post.

At the time I left India, this plan had not been approved by the various ministries concerned. I feel certain, however, that it will be put into effect much to the benefit of higher education in India.

Another plan consists of sending teachers or graduate students for study abroad in the United States, the United Kingdom, Germany, Belgium, France, the Netherlands, Switzerland, the Scandanavian countries, and the USSR. This plan has been in existence for the past decade. It

is, however, less desirable than the first plan because of the cost involved. The cost of 5 to 10 scholarships under the first plan is equivalent to the cost of only one under the second plan. The cost, of course, depends upon the cost of education in the foreign country to which the teacher or graduate student is sent. The need is urgent and the demands on the budget of the Government of India do not allow the luxury of sending many graduate students abroad.

A third plan is the "Participant Program," instituted by the Government of the United States, whereby selected faculty members are given scholarships to various educational institutions in the United States for a full years' study with all expenses paid by the United States Government. This program suffers from the one-year limitation and would be effective, although costly, if the Indian faculty member was allowed to remain until he received his Ph.D. Another defect of the participant program is that it attempts to improve the knowledge of those already in the teaching profession rather than to create new teachers which is really the more urgent need of India.

The fourth program consists of furnishing American teachers to Indian universities. This takes two forms: the Fulbright Program and the ICA Program. Under the provisions of the Fulbright Act, monies due the United States, from the sale of surplus equipment after World War II, is retained by the Foreign Government and used to pay salaries and expenses of American professors who go to India. Under the ICA Program, a contract is entered into between ICA Washington, D. C., and an American university to supply faculty members to a selected group of Indian universities. These American educators go to India for varying periods of six months to two years and help the Indian university to which they are assigned, in teaching, doing research, guiding graduate work, or organizing laboratory facilities, curricula etc. I believe that the United States is rendering a very much needed service to India in sending its educators to perform such tasks. I also believe that American educators who go to India under this program are ambassadors of good will and contribute to the understanding between these two great nations. The cost of this program is very small indeed, compared with the good will it creates and, from my own experience, I support it wholeheartedly.

The USSR is sending help to India along lines similar to those of ICA Washington; the British Commonwealth also sends educators to India under the Columbo Plan. Finally, the United Nations has a mission in India, one object of which is to aid in India's educational problems.

Thus, India is fully cognizant of the problem of staffing its new universities and technical institutes, and raising its standard of technical education. The Government of India is doing its utmost to solve this problem alone when it can and with the help of friendly nations when this help is needed and requested.

Equipment and Libraries

Equipment is a necessary part of all technical education. It is needed for both undergraduate and graduate study. The laboratories for undergraduate teaching are, on the whole, adequate, although improvement is necessary in most cases. The equipment for graduate work is almost nonexistent and its procurement from foreign countries involves delays and red tape which are hard even to visualize. ICA Washington realizes this situation. Hence, it invariably includes, in its contracts with American educational institutions, provisions for the purchase, in the United States, of equipment which the American teacher deems necessary to carry on his duties in India. Our Government has also entered into an agreement with the Indian Government to allow all such equipment to enter India duty free. Through these provisions, many Indian technical institutions and universities have received much-needed American equipment for both undergraduate and graduate instruction. The need is, however, extremely great and the Governments of India (both State and Union) have supplied much of the equipment through appropriations to technical education. In this connection, may I state that the Indians are a very proud people. They appreciate the help they are receiving from the United States and other foreign governments but they do not seek handouts. They look at the problem just as we do, of co-operation among peoples and nations for a better, happier, and more peaceful world. This is why they like the names of Technical *Co-operation* Mission (TCM) which is the representative in India of the International *Co-operation* Administration. This matter cannot be overstressed. It is the cornerstone of success in our relations with India and should be the watchword of every American who accepts a foreign assignment. India is ready and willing to co-operate with other nations under similar conditions. The WRDTC mentioned previously is one instance of such co-operation.

Just as essential as equipment, are good technical libraries. Books are extremely expensive in India. There are very few technical books written by Indian authors and published in India. Most technical books are imported either from the United States or from the United Kingdom. An $8 book in the United States is worth Rs. 40 in India. It does not take many books to exhaust library appropriations. No student can afford to buy books at such fabulous prices. McGraw-Hill Book Company has found one solution to this problem. They have had some of their more popular books reproduced in Japan at a cost equal to about one third the cost here. These books are distributed throughout the Far East and have done much to lighten the financial load of students and university libraries. Most libraries, however, need books and back volumes of technical magazines such as the AIEE *Transactions*, *Electric Journal*, *Electrical World*, the *Proceedings* of the British Institution of Electrical Engineers, and the *Bell Technical Journal*, to mention only a few publications in the field of electrical engineering. If any one reading this article wishes to contribute his library to an Indian university, I shall be glad to see to it that the books are packed in his home and shipped to that university at no cost to the donor and with as little inconvenience to him as possible.

Because of the scarcity and dearness of technical books, a very effective method of helping technical education in India is for the foreign teacher to write books or pamphlets in his specialty and have these reproduced in mimeographed form for the use of his and other students in India. I have no knowledge to what extent this is done in India. I did act on this idea and caused to be published by Roorkee University and other universities the following series of lectures: Electric Circuit Analysis, which were based on my book "Electric Circuit Analysis" (mimeographed); Refresher course lectures on Symmetrical Components and Fault Currents as well as on Transmission Lines (mimeographed); Dimensional Analysis (mimeographed); Electrical Machine Design (mimeographed); Magnetic and Dielectric Circuits (mimeographed); The Ranque-Hilsch Tube, published in the 1956 issue of the Roorkee University *Annual Magazine*; Fourier Series (mimeographed); Symmetrical Components and Fault Currents, published by the *Indian Construction News*; and Laplace transforms (mimeographed).

Cost of Technical Education

Education is extremely cheap in India, as compared with the United States. Most educational institutions are supported by the State and Union Governments. In this case, they resemble our state universities. The tuition and fees are about Rs. 150 ($30) annually. The student spends about Rs. 1,275 ($255) per academic year. This is about 10% of the annual educational expense of an American student. The writer has no estimates on the average income of parents who send their sons to the universities in India. A fair guess, however, would be between Rs. 300 and Rs. 400 per month. Thus, it takes three or four months salary to pay the expense of a child in a university. What makes matters worse is that there exist no opportunities for self-help. Menial labor is shunned by Indian students for the reasons already mentioned and there is little likelihood that the American system of student self-help will ever be popular in India. Therefore, it would appear that the only method of solving the economic problems of Indian students is through loan funds and scholarship grants. The need for student help is so great that the vice-chancellor of Roorkee University started a successful campaign among faculty, alumni, and others to establish a student Loan Fund which could be used by the University to relieve temporarily the financial needs of some highly deserving students, who, through death of parent or some financial reverses, cannot continue their education without assistance.

Here is an opportunity for the Ford Foundation, which is doing excellent work in India, or some other philanthropic or-

ganization, to lend a helping hand not only in Roorkee University but also in other universities of India. I would suggest that the donor match such student aid funds rupee for rupee that the universities are able to collect from their alumni and friends.

Opportunities for Employment

India has the anomaly of industrializing rapidly, graduating an increasing number of engineers, and yet being unable to offer employment to all its engineering graduates. Generally, all civil engineers ultimately find jobs. This is not the case with mechanical and electrical engineers. This situation is unbelievable but it is true. A complete analysis of this problem is beyond the scope of this article.* Suffice it to say that because the greater proportion of Indian industry is owned and controlled by the government, red tape is inevitable. This results in a lag of several months between the time a student graduates and the time he is employed. Thus, there always exists a group of unemployed engineers among the recent graduates. A second factor is that private industry is loath to invest money in a program of training cadet engineers; nor does private industry offer security to its engineering employees. Hence, technical graduates are not attracted to private industry. They prefer government jobs even though these necessitate a period of initial idleness. The Government of India, the universities, and Indian industry are cognizant of the situation and are seeking ways and means to remedy it.

Research Institutes

Side by side with the building of new universities and new technical institutes, the Government of India, since independence in August 1947, created the Department of Scientific and Industrial Research ". . . to supervise and co-ordinate research work undertaken by the State and private institutions." Subsequently, this department became a part of the Ministry of Natural Resources and Scientific Research which was established early in 1954.

The Council of Scientific and Industrial Research is an autonomous government body whose purpose is ". . . establishing, maintaining, and managing laboratories and institutions devoted to scientific and industrial research." The Council awards research scholarships and fellowships and utilizes the results of research for the development of industries. It also publishes scientific papers and journals to disseminate information on scientific and industrial matters.

The activities of the Council are financed mainly by the Union Government. The grant for recurring expenses in 1953-54 was Rs. 17.4 million (approximately $3.5 million). The estimated expenses for 1955-56 was Rs. 21.39 million (approximately $4.3 million). Grants of lands and buildings are given to the Council whenever it plans to establish a research institute. The costs of land, buildings, and equipment are nonrecurring expenses and are not included in the foregoing figures. Hence, these figures do not represent the total expenditure of the Government of India on scientific and industrial research. Since independence, 14 national research laboratories, which undertake both fundamental and applied research, were established. The cost of these laboratories up to March 1955 was Rs. 41.79 million (about $8.4 million).

To show the importance which India attaches to research, it is well to note that the Council is administered by a governing body with the Prime Minister as president and the Minister for Natural Resources and Scientific Research as vice-president. Other members of this governing body include representatives of the Ministry of Finance, of Business, and of Industry. The governing body receives advice from a Board consisting of 19 men of whom 9 are eminent scientists. It has 25 research advisory committees in various fields.

In addition to the newly established institutes of research, there are others either entirely privately supported or financed partly by the Union Government.

The author would like to call particular attention to the laboratories of the Indian Academy of Science (Raman Institute) in Bangalore. Sir C. V. Raman is a Nobel Prize laureate in physics. He is, without a doubt, the greatest Indian physicist. He gave all his accumulated funds as well as the Nobel Prize money to establish this institute of research, which in five years published 94 papers describing the researches of Dr. Raman and his colleagues in various fields of physics with particular emphasis on crystal structure, luminescence, irridescence, and other optical phenomena. The author had the pleasure of spending an afternoon with Sir C. V. Raman, a gentleman in his middle 60's with the enthusiasm of a youth for his institute and its researches. The only support which he or his institute receive from the Union Government is his salary of about $400 as National Professor of Physics. He shares this salary with his colleagues, taking for himself only what is absolutely necessary to supply his and Mrs. Raman's very simple wants. His other sources of income are little contributions from friends and admirers. I have never met an individual more devoted to the cause of science. I promised Dr. Raman to tell his story to America in the hope that it will touch the heart of some philanthropists or an organization which might give his institute the needed financial backing.

Conclusion

This paper may be summarized as follows:

(1) India, since independence, has forged ahead in technical education both through its own efforts as well as with the aid of other friendly nations including the United States.

(2) The students in India are highly intelligent because they are selected on the basis of an entrance examination. They do not suffer distractions arising from extracurricular activities. They shun menial labor.

(3) Indian universities offer courses not generally offered by American universities. These include the diploma courses and the refresher courses.

(4) A new experiment in international graduate work has been established in Roorkee, namely the "Water Resources Development Training Course."

(5) In general, the faculties of Indian universities need improvement. The Indian Government is doing its utmost to effect this.

(6) The equipment for undergraduate study is adequate. However, the equipment for graduate study and research leaves much to be desired.

(7) The cost of technical education in India is very low as compared with its American counterpart. However, considering the income of Indian parents, educational cost is very high.

(8) Opportunities for employment of technical graduates are not as good as they are in the United States.

(9) India, since independence, has established several research institutes, universities, and technical institutes. The Union Government of India spends relatively much more on technical education than does the Federal Government of the United States.

(10) There are private institutes of research which are struggling hard to make ends meet. Among these is the Raman Research Institute at Bangalore.

References

1. *India* (The 1956 Annual).

2. University of Roorkee Syllabus 1954-55, 1955-56.

3. University of Roorkee (WRDTC) Annual, 1956-57.

*The writer made an analysis of this problem in an hour's lecture delivered to the faculty and students of Roorkee University. The vice-chancellor has a copy of this lecture and will undoubtedly bring it to the attention of the proper authorities, if he has not already done so.

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Special Programs Offered by MIT During Summer

The following Special Summer Programs will be offered by the Massachusetts Institute of Technology (MIT):

Electrical Energy Conversion and Control, July 8-12, under the direction of Dr. Mahmoud Riaz, assistant professor of electrical engineering.

Advanced Feedback Control Theory, July 21-August 1, under the direction of Dr. W. W. Seifert, associate professor of electrical engineering.

Problems of High-Powered Radar Design, September 2-12, organized by L. D. Smullin, associate professor of electrical engineering.

Editing Technical Reports, September 2-12, Prof. R. R. Rathbone, department of humanities, will be in charge.

For further information, address the faculty member in charge of arrangements at Massachusetts Institute of Technology, Cambridge, Mass.

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Search Started for Outstanding Electrical Engineer

Eta Kappa Nu, national electrical engineering honor society, has begun its 23rd annual search for the nation's outstanding young electrical engineer. Eligible for the society's award is any man who, on May 1, 1958, had been graduated not more than 10 years from a course in electrical engineering at an American or Canadian college or university and who is not more than 35 years of age.

The Eta Kappa Nu recognition of the outstanding young electrical engineer is intended to emphasize among electrical engineers that their service to mankind is manifested not only by achievements in purely technical pursuits but in a variety of other ways as well. Selection is made on the basis of the candidate's record of achievement in his chosen work, in his service on behalf of his community, state or Nation; in his cultural or aesthetic development; and in the service rendered to his profession.

Eta Kappa Nu, the sponsor of the annual award, is the national electrical engineering honor society founded at the University of Illinois in 1904. The organization has more than 29,000 members, 74 college, and 12 alumni chapters in the principal cities of the United States.

Selection of the 1958 Recognition Award winner as well as possible honorable mention recipients will be made in the Fall by a Jury of Award consisting of several leaders in the electrical engineering profession. The award will be presented at a banquet in New York, N. Y., in February, 1959.

To assist the Jury of Award in their deliberations, each year the nominations for the Outstanding Young Electrical Engineer are given a preliminary processing and evaluation by the society's Award Organization Committee. This group arranges for collection of references and other supporting data.

Every effort is made to secure nominations on a nation-wide basis. Last year the records of 95 candidates representing all the geographical areas of major engineering activities in the country were scrutinized by this group.

The Committee membership for 1958 under the chairmanship of J. H. Craig includes Robin Beach, L. Dwon, E. S. Lee, B. F. Lewis, J. W. Montstream, J. H. Mulligan, Jr., J. D. Ryder, R. I. Wilkinson, and F. W. Young.

Nomination forms may be obtained from A. B. Zerby, Executive Secretary, Eta Kappa Nu Association, P. O. Drawer 447, Dillsburg, Pa. Nominations should be returned to Mr. Zerby not later than May 31, 1958; nominations received after that date will be processed, but dossiers may not be complete when the Jury of Award meets in October.

Industry Viewpoints on Educating Electrical Engineers

W. S. HILL
FELLOW AIEE

BEFORE HE RETIRED as president of Brown University, Dr. Henry M. Wriston defined the responsibilities of a dean. With his customary perception and humor, he said it was the job of the dean to make the college what the president says it already is. This suggests that our objective at this week-end conference of professors of electrical engineering is to make electrical engineering what the American Society for Engineering Education (ASEE) and Engineer's Council for Professional Development (ECPD) say it is currently. This topic is one which always generates many differing opinions anyway, but we were asked to choose our remarks purposely to raise problems and questions rather than produce answers.

A special article based on a talk given at the Conference on Electrical Engineering Education, Sagamore Conference Center, Syracuse University, May 31, 1957. Recommended for publication by the AIEE Educational Publications Committee.

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First, we might ask ourselves why these differences of opinion exist. I don't think it is a question of old vs new or whether some of the programs being advocated by different sponsors are right or wrong. Technology is changing rapidly, and the problem we face in the colleges is what to do about it and how we can most effectively prepare the coming generation of young people for these inevitable future changes. Technical progress and social progress are running on entirely different clocks, and it is this fact that is raising many of the problems in society today. In the same way, we can say that technological developments and education may be running on different clocks, and this may very well be the main reason why we have a meeting such as this today.

In its simplest form, my concept of the objective of engineering education might be reduced to one sentence. An engineering program should assist competent and responsible individuals to obtain the essential educational background and stimulus which will permit them to achieve full professional engineering status and make the maximum possible contribution during the years of future practice.

It might also help to restate the steps through which engineering problems are solved. Again using simple terms, we must first define the problem, then recognize the relationships of the parts, examine and analyze the component parts, plan a method of attack (preferably using some creative approach), find solutions based on fundamental principles, appraise the solution using both functional and economic criteria, and finally conclude with either a report or a decision.

Since I am speaking to an academic group, but from the standpoint of one in a specific industry, I would like to put this discussion in perspective. There is a tendency for each generation to think it is on the crest of historical development. We have heard the expression "we are living in the age of chemistry, or electronics, or nucleonics." Actually these so-called ages are supplementing and complimenting each other. We can take almost any area of technical development and illustrate the acceleration to which all technology is subject. Transportation, for example, shows us that for thousands of years the speed of a horse determined the maximum speed at which human beings could move, or roughly 30 miles per hour. By 1900, railroads permitted 100 miles per hour, and today jet planes are capable of operating substantially above 1,000 miles per hour. We know that the work on rockets and the laboratory work on shock tubes at Mach numbers above 22 are the forerunners of speeds far beyond these figures for human transportation at some future time.

If we turn to the electrical field, our discussion can readily be divided into three broad areas. Those of us in the electrical manufacturing business are concerned with problems and products in all three of these areas—materials, information conversion, and energy conversion. Each of these illustrates a growth trend similar to that of the transportation business. Materials today represent perhaps 10% of our business, and while still small, note that in 20 years it has actually increased 16 times. A second category is that of information conversion which comprises roughly a quarter of our total business at the present time; in terms of dollar business, this has grown 15 times in a period of 20 years. Energy conversion accounts for 65% of our business volume, and this has been growing to this magnitude over a period of more than 60 years.

Since the annual volume is totalled in billions of dollars, these figures show the very large dollar volume involved in energy conversion. Just under 60% of our technical personnel are working in this area, about 37% in the region of information conversion, and the balance in materials. Obviously, if a company such as an electrical utility is scrutinized, one would find that an even larger proportion is encompassed by the term energy conversion. However, if you examine one whose business is purely electronics, you would find that nearly all of it was concerned with information conversion and materials. The point is that in our present economy, dollar volume and numbers of people are very high in two of these three categories

in the electrical industry alone, and the planning of our educational system must be adapted to these realities.

Materials Problems

It may be helpful to choose a few examples to illustrate these different areas and their interrelations. We now realize that in the 1920s, we lacked a full explanation of what went on in rotating machinery. I believe we are justified in saying that between field theory and circuit theory this is no longer true and that our limiting problems in rotating electrical apparatus have now been transferred to the materials category. However, as we solve our materials problems through new developments, we find that this opens up new horizons in designs and in applications which require us to go back and apply entirely new concepts to problems which we thought had been fully solved and disposed of in past years. This is one of the reasons why there are such widespread opportunities in the field of energy conversion and why proper presentation of these subjects is so important in the colleges.

These advances in design stem from the growing advances in materials. New alloy steels, oriented grain magnetic steel, insulations, and semiconductors are illustrations which lead to product improvements. The important influence which materials have on design is illustrated in countless places. A single shaft 3,600-rpm generator installed 10 years ago was rated at 111,000 kva. Today, we have a 384,000-kva unit on the drafting boards and are predicting ratings over 500,000 in the future. If this talk were being given in 1962, these figures might well be used again to show how far we have advanced since the '50s.

Let's take the area product field represented by induction motors. I suppose a typical student thinks there is little new in motors, whereas, actually, great progress has been made based on new materials and on a better fundamental understanding. If we take a given frame size with specific dimensions, we find that in 1906 an output of 10 hp was produced from these dimensions, in 1930 it was 20 hp, in 1940 it was 30 hp, and in 1950 it was 40 hp, all using standard temperature rise limitations. Today, using new synthetic insulation and making full use of temperature limitations, the output can be substantially above 40 hp.

The field of semiconductors and the development of transistors graphically illustrate the technical progress which a new material makes possible. These result in the redesign of many of our electronic and computer circuits. A tremendous amount of work in the area of development, design, and manufacturing methods is involved as we introduce transistors in place of vacuum tubes for appropriate applications.

Information Conversion

A few illustrations of new problems in the field of information conversion can be informative. Because missiles represent a timely topic, fall in the defense category, and have considerable glamour from the standpoint of students, the subject of missiles makes a good example. Those of you who are working in this area are impressed with what the system type of thinking (including feedback control using the techniques of electronics) is contributing in the missile field. Problems which we still face include getting an increasing amount of information back through the stratosphere from these missiles and the problem faced by radar; namely, accurate discrimination in tracking sky objects. Many of you in the graduate area are concerned with low noise tubes and the problems of signal detection in the presence of all manner of external "noise."

The field of numerical control applied to machine tools illustrates another facet in this field. A substantial amount of our manufacturing space is devoted to systems of this type. Here one sees punched cards, punched tape, and magnetic tape all being used to program machine tools such as special presses, lathes, milling machines, and many other devices which are part of the automation techniques of the future. In this, we see combinations of electronic, mechanical, and pneumatic devices engineered together to provide a group control system.

Some developments are of the static variety. Take the magnetic amplifier which is a relatively old device but markedly new in standard application. Magnetic amplifiers are developing a field of their own and are replacing many relays and contactor applications using logic elements which can be combined in a great variety of forms. Because of the reduction in moving parts and a corresponding elimination of wear, we are entering a period where long device life with a minimum of maintenance is becoming possible.

Another illustration can be drawn from the work in the electronic recording machine accounting field. Basically, this applies many of the information conversion techniques to the general field of banking or similar accounting procedures. Several different systems are being developed around the country. In one method, personal checks are imprinted with magnetic numerals so that they may be passed through check sorters to enable the present checking account system in a bank to be handled automatically. This involves not only sorting and reading out the amount of the check and the account number, but the passing of the information to storage units, calculating a new check balance, recording and storing the new balance for the appropriate account number and bank, and finally printing out the monthly statement for the customer. Like some of the examples in the materials area, these in information conversion demonstrate the range of problems which students of yesterday are working on today, and in turn suggest many problems for tomorrow.

Energy Conversion

Some of the trends in generators were touched on when illustrating the effect of materials on new developments. Transformers are undergoing similar developments as we extend our knowledge of transients, impulses, and oscillation effects. You might ask what new methods are available when a design or application engineer attacks the problem of transformers. Both you and your students will be interested in the vastly different approach which results when computers become an integral part of the design procedure in these so-called older fields. The IBM *705* computer which General Electric Co. (GE) is using will permit optimizing complete designs to specific end points within a few minutes instead of periods of days or weeks as formerly required. Its first use has been in the preferred power transformer ratings and is being extended to the very largest sizes. Through the optimizing process, we now have effective techniques not only for achieving designs rapidly but also for achieving them with minimum materials.

Progress in circuit breakers is equally illustrative of the progress being made. Not so many years ago, an interrupting capacity of 3.5 million kva was considered an important achievement. Now breakers of 25 million kva at 3 cycles are taken as a matter of course at the higher voltages, and manufacturers are talking of 40 million with predictions in the long-range future at 60 million kva to take care of the power systems of the future.

Or we might return to the subject of motors. How many schemes have each of us thought about to get an a-c motor with the speed control characteristics of a d-c motor? I have been interested in some of the latest proposals involving double winding induction motors combined with saturated reactors providing full control to go from full speed in one direction to full speed in the other direction with any designated speed between. It appears possible to do this with the same efficiency and losses as many alternative schemes. So, after 60 years or more of working with a well-known device, another idea is injected which may permit a reappraisal of an old application problem.

The design of many motors today illustrates again the new techniques. Rather than using the former equation methods and existing design books, present technique involves the use of computers and a circuit approach. This starts with an understanding of fields, and ultimately involves circuits which can be set up on the computer. With previous techniques, solutions involved many assumptions and considerable difficulty in the solution. Today, far more exact solutions are possible.

Turning to the power systems themselves, we find that applications of new devices may revolutionize our thinking in the electric utility area. Using equations of self and mutual inductance, the initiated can write complete equations, then combine these in meshes which accurately represent the complete systems circuit; as, for example, a power transmission system. If we had to rely on arithmetical methods, little could be done with this, inasmuch as a 25-mesh system might require 250,000

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arithmetical operations to solve. With an IBM *650* or an IBM *704* computer, this might be done in a matter of minutes.

These new means for solving mathematical problems open up extremely interesting new fields for study and decision making in the electric utility area. An obvious application is loss calculations on transmission systems. Load flow, scheduling problems, and circuit studies which were made on d-c calculating tables with a-c network analyzers, often utilizing symmetrical components, are now turning to the new techniques. Transient studies can be made readily with digital computers with the results being actually printed out for ease of review. Radio interference problems on high voltage lines may also utilize these new techniques.

Mechanical design problems also benefit by the computer approach. Examples are piping and foundation problems in a steam plant, heat balance determinations, coal sample analysis, and mechanical stresses on bus bars during short circuits. Economic considerations lead to computer studies on energy loss allocation problems involving cross billing between several utility systems using common transmission lines. Load forecasting, reliability of power systems in terms of probability, and optimum generator size for a given system illustrate this approach. There is every indication that the broadly trained power system engineer of the future will be using these techniques rather than the manually limited solutions available heretofore.

Illustrations of new approaches are also at hand in the nuclear power field. For the present at least, the heat produced through atomic radiation is translated into electrical power through conventional means, namely the steam turbine-generator. As we move back into the nuclear boiler, applications of control techniques are found. Temperatures have to be monitored through the whole critical reactor element structure to insure a balanced temperature and proper heat distribution. The techniques which the engineer uses always go back to fundamentals, whether the equipment be of the pressurized water design or utilizes liquid sodium and the magnetic pump. In general, the electrical engineer has found it rather easy with his knowledge of fields and circuits to adapt himself to these newer applications.

In my own observations of work and people in the nuclear field, I have been impressed with the number of times that individuals cross the boundaries of the disciplines in which they were initially trained. It is a common experience to find mechanical, electrical, chemical engineering, and physics trained people all grouped together and to a great degree losing their specific identifications in the interests of the project which itself recognizes no artificial boundary of the academic world.

Feedback in the Field of Education

At a meeting like this, it is appropriate to apply one of our own principles, that of feedback of information. You who are educators may be interested in these observations applicable to the electrical engineer as they assume their industrial responsibilities. These graduates have many strong points, but at the same time we find weaknesses which, if understood and anticipated, might be modified and corrected. As they are assigned heavy technical responsibilities, they often encounter non-electrical problems but fail to realize that the principles of electrical engineering can be applied to them. Mechanical vibrations might be used as an example. An electrically trained man can use the concepts of oscillating a-c circuits, but unless he has truly understood the fundamentals in this field, he may not be able to make the necessary transition. Often, he knows how to solve such a problem but does not know that he knows it. Perhaps this is a failure to relate what is learned in electrical engineering back to his physics program and to laws which govern the behavior of materials and matter.

Another example of this lack comes out of observations of men entering the GE Advanced Training Course. Many of these people can quote the proper words, but do not really understand Faraday's Law of flux in a closed loop. The same might be true of other laws such as Ampere's which, while rather elementary, has not been learned well enough to permit maximum utilization.

Perhaps a third area is that of problem solving. The GE advanced courses stress this area particularly. Basically, the problem is to give new graduates the knowledge and confidence to make transitions between several disciplines. GE tries to generate flexibility so that mechanical and electrical subject matter can be combined with the basic physics and mathematics needed to produce workable answers.

Electrical engineers are by and large much more versatile than those in other disciplines. In general, their mathematical training has been somewhat better, at least until recently. They understand conceptual models better, probably for the reason that they are accustomed to the abstractions of fields and voltages and currents. The physics graduate understands these techniques, but his interest generally follows the theoretical approach, whereas the electrical engineer is usually oriented to the practical application to be made of the theory. The mechanical engineer is, in general, accustomed to visualizing devices and working with physical models. It has been suggested that this concern with models rather than abstractions is one of the reasons why it is harder for a mechanically trained man to move into the electrical field rather than the reverse.

It may be of interest to quote observations by several experienced engineers concerning matters relating to academic training. J. F. Young, one of GE's consultants, expresses the current situation as follows:

"Practice is changing so rapidly under the impact of the growth of science and technology, that its teaching might be obsolete before it can be used. Fundamental training in the basic and applied sciences is, therefore, the only foundation on which the curriculum can be built with confidence. With such a foundation, the young engineer can best meet the variety of problems that will arise in industry and can also train himself as he keeps up with the growth of his profession.

"The field of practice is continually growing in breadth and has more and more relationship to individual manufacturers, with the result that the universities cannot hope to keep up to date with it all. Industry, whether represented by large or small manufacturers, is becoming convinced that it is best adapted to provide experience in practical applications. By contrast, it is, of course, recognized that the universities are best equipped to teach the science that underlies engineering practice. Perhaps the best example to prove the point is the versatility of electrical engineers. Their training has in the past been closely related to the sciences, and in industry they have been the most adaptable to the new fields of engineering.

"The problem of engineering education must, therefore, be a continual one of discarding precepts founded upon art for the more basic principles founded upon science. It must also involve the continuous integration of subject matter as concepts are extended and this integration becomes feasible. If one looks back a decade or two, it appears obvious that this has occurred. It seems equally correct to assume it is the only pattern for the future."

K. A. Kesselring, one of our experienced managers in the atomic field, has this to say:

"To attempt specialized training in such rapidly moving fields as exist today in engineering and science is hopeless at the bachelor level. The salvation is the thorough education in the use and understanding of fundamentals. Each new breakthrough in technology invalidates much of what exists in empirical form or in handbooks. Until the new area has been more completely explored, standards established, and appreciable experience obtained, progress is measured by the ability of the engineer and scientist to apply fundamental theory to the many newly recognized problems."

What about the problems ahead? The fuel cell, solar energy, purification of sea water, controled thermonuclear fission as a source of power, the extension of computers in the fields of manufacturing and office procedures are examples of the unsolved areas which those who are students today will be working on tomorrow.

They say that Norwegian pilots are trained not so much to fly the plane but to fly ahead of the plane. This means doing their thinking ahead of time so that in actual flight automatic pilots or others can take over and free the pilot for considering fresh problems as they arise. Perhaps this holds a suggestion for us in electrical engineering, namely that we should train our students not for what we see today, but for the tasks ahead.

Technical Education in Britain

D. O. AKHURST

FEW NATIONS TODAY can be unaware of the fact that during the past 50 years the technological application of scientific discovery and invention has yielded far greater changes in the pattern of human life and livelihood than the world has ever known before. The future of few countries could be as dependent upon the quality of their response to this challenge of change than the English and, for this reason, technical education has been and is receiving considerable attention in England at the present time. It has been recognized by the government, the local education authorities, and by industry in that country that insufficient people are being trained for responsible positions in industry.

The English universities have been prevailed upon to double their output of highly trained scientists and technologists; their faculties of technology have undergone developments financed by the English Treasury. The English technical colleges have pledged an increase of 50% in the output of students from advanced courses and an increase of 100% in the number of apprentice technicians and craftsmen released by employers for part-time courses of study during working hours. To aid these colleges in this expansion, the English Treasury is appropriating £100 million for expenditure over the five-year period from 1956 to 1961. The importance attached to increasing not only the numbers of highly trained scientists and technologists, but also the supply of trained technicians and craftsmen reflects the view that for every technologist, industry needs five or six trained technicians from whom come the bulk of the foremen and technical assistants in modern industry. Below them more than one third of the operatives now need to be trained as skilled craftsmen, from whom an increasing amount of scientific knowledge is required.

Modern technology calls not only for increased scientific skills, it also demands additionally technical enterprise, a high degree of adaptability, organizational ability, and good human relationships. It is the aim in England to train men who combine high scientific skill with fervor of purpose and courageous imagination.

Primary Education

Primary education in England[1] is compulsory from the age of five years; however, many children attend kindergarten or nursery schools for two or three years before that age. The majority of the parents of children reaching compulsory school age elect to send their children to the public elementary schools where tuition is free and the school often conveniently located. The children go to school for six hours a day from early September until late July with two weeks holiday at Christmas and a little less at Easter. Not more than 10% of the time up to the age of 11 years is spent on scientific subjects and little of this time is devoted to the physical sciences. A number of parents prefer to send their children to private schools where the fees vary depending on the status of the school, extra curricular subjects studied, and whether the child is a boarder or a day pupil. The private preparatory school accept pupils at 5 years of age for preparation for entry to the public or boarding schools at 8 or 12 years of age. The boarding schools take fee-paying pupils up to the age of 18 years and offer preparation for examinations leading to university entrance, civil service entrance, officer selection, and various branches of finance and commerce.

Secondary Education

Those children who attend public elementary schools are examined in their 11th year and are offered places in secondary schools where all tuition is free. There are three possibilities at this level of education:[2] the secondary grammar schools, the secondary technical schools, and the secondary modern schools.

Secondary Grammar Schools. The aims of the secondary grammar school education are similar to those of the boarding school; however, whereas the emphasis is laid on pure science in the grammar school, the boarding schools place greater importance on the classics. The grammar school curriculum in pure science may include two, three, or four years of physics, chemistry, biology, and other general science subjects. The fifth and sixth years include physics, chemistry, and natural science; these subjects generally being taught separately. Natural science covers botany, zoology, some physiology, a little geology, and anatomy.

Secondary Technical Schools. The secondary technical school, a relative newcomer to the scene of secondary education (1944), is destined to supply industry with a large proportion of the technologists and technicians so greatly in demand at the present time. This type of school is introducing technical and applied science concepts to its pupils from the earliest stages of their secondary education. The curriculum is balanced to avoid premature specialization of a vocational character; nevertheless, the broad objectives of an industrial career are kept in sight. There is a tendency for regional demands to dominate the branches of industry covered by particular schools, however, the different occupations and the different groups within the industry ensure a broad educational foundation leading, for example, to the recommendation that a foreign language should be included in the curriculum not as a compulsory subject, but rather for the benefit of those pupils interested in foreign technical literature.

Secondary Modern Schools. Those children whose particular abilities and interests do not lie in either the secondary grammar or secondary technical schools complete their education in a secondary modern school. Here, the educational objective is one of enlarging the horizon of the pupils. Although the curriculum includes some scientific subjects, the emphasis is not usually in this direction, so that apart from the fields of study associated with nursing, agriculture, car repair, etc., this type of school does not contribute greatly to the numbers employed in technical or scientific pursuits. However, it does ensure that a large proportion of the population is made aware of the important part played by modern science and technology. Furthermore, these schools provide adequate numbers of well-trained auxiliary personnel for industrial and commercial offices, inasmuch as secretaries, typists, clerks, receptionists, tracers, etc., receive their education mainly at the secondary modern Schools.

Higher Education—the Universities

The education of pure and applied scientists in England is shared between the universities and the technical colleges, each of which makes a distinctive contribution to the field of technical education. The objective, since 1945, has been a total expansion of the facilities of both types of institution. The 15 degree giving universities[3] are those of Birmingham, Bristol, Cambridge, Exeter, Durham, Hull, Leeds, Liverpool, London, Manchester, Nottingham, Oxford, Reading, Sheffield, and Southampton. The University Colleges of Leicester and North Staffordshire are grouped with the universities but only North Staffordshire has the power to grant degrees and this power is limited to the degree of bachelor of arts. Oxford and Cambridge Universities, each with a number of colleges, are very old foundations and completely residential. Of the remainder, Durham and London Universities include groups of largely autonomous colleges, but all of the universities except Oxford and Cambridge have been established since 1800 and, with one or two exceptions, are mainly nonresidential. The total number of full-time university students in 1956 was 81,700 of whom 25% were women students and 64,600 were studying for first degrees. University degree courses generally extend over three or four years and all universities provide for postgraduate work and research. Although universities are self-governing institutions, they receive aid from the Government Treasury in the form of direct grants awarded on the advice of the University Grants Committee. This committee is composed of academic experts and

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is under the control of the Treasury and not the Minister of Education.

Grants, Scholarships, Exhibitions

Government State Scholarships tenable for courses for all honors degrees at the universities are offered each year by the Ministry of Education; they are awarded on the results of the General Certificate of Education Examination to pupils attending secondary grammar and technical schools. In 1956, 2,410 new State Scholarships were awarded on this basis. Also, 1,557 State Scholarships were awarded to pupils offered Open Scholarships at the universities. Technical State Scholarships awarded in 1956 were about 120 and Mature State Scholarships for those wishing to attend a university later in life numbered around 30. Some 12,400 scholarships with maintenance grants were also awarded by local education authorities to enable selected pupils to proceed to the universities. Numerous exhibitions and scholarships are awarded by all universities and colleges—notably Oxford and Cambridge Colleges—from their own funds, private trusts, and benefactions.

Student Expansion

The universities have expanded greatly since World War II, the expansion chiefly in the scientific departments. In 1946, the Committee on Scientific Manpower recommended that the universities should double their output of scientists and technologists. As a result, full-time university students of science and technology increased in number from 13,000 in 1938-39, to over 27,000 in 1950-51. This increment was partly caused by the ex-servicemen students. However, it was not long before the number of university students reached a new peak of 29,000. Of these, over 6,000 were graduating every year with first degrees in science or technology; pure science accounting for 4,200, of whom probably over one half were entering industry. Despite these efforts, it is estimated that there is a shortage of scientists and technologists of between 1,300 and 2,500 with particular shortages in aeronautical, chemical, mechanical, and electrical engineering and in the chemical, physical, and metallurgical sciences.

University Expansion

In addition to the efforts made to increase the number of university trained technologists and scientists, the English government has provided financial support through the allocation of grants by the Universities Grant Committee towards capital expenditure for buildings for teaching and research in science and technology. Over one half of the £24.5 million spent or committed for the University Building Program has been "earmarked" for buildings for teaching and research in technology and science including medicine. This expenditure does not include the expansion of the Imperial College of Science and Technology announced in 1953, whereby the student numbers will be increased from 1,650 to 3,000 at a cost of approximately £15 million, nor does the expenditure include the development program, outside London, in which science and technology in provincial universities will be financially supported. Approximately £5 million for buildings and £1.5 million for equipment is destined for projects in chemistry (Birmingham, Leeds, Newcastle, Sheffield); chemical engineering (Birmingham, Cambridge, Manchester); engineering (Bristol, Glasgow, Manchester, Newcastle, Southampton); fluid mechanics (Cambridge); fuel technology (Leeds, Sheffield); mining engineering (Sheffield); physics (Birmingham, Leeds).

University Entrance

The admission requirements for pure and applied science departments of English universities are relatively high. Candidates for admission are required to demonstrate or have demonstrated their ability in differential and integral calculus, conic sections, trigonometry, statics, hydrostatics, dynamics, electricity, magnetism, optics, accoustics, thermodynamics, organic, inorganic, and physical chemistry. The prospective student, although sufficiently qualified, may not be successful when applying for university entrance because of competition from better qualified applicants.

Examinations

All students of science and technology are examined thoroughly once or twice a year. The examinations are usually of three hours duration for written papers and six hours for laboratory examination. Frequently, there are two or more examinations for each course in order that the full syllabus may be thoroughly examined. Considerable care is taken in the preparation of the examination; the questions and solutions usually being discussed with an external authority for the purposes of moderation and assessment.

Degrees

The first degree in pure and applied science is the B.Sc. or bachelor of science (at Oxford or Cambridge the B.A. is awarded). The degree is awarded with honors as a first class honors degree, an upper second class honors degree, or a lower second class honors degree. When not awarded with honors the pass degree is specified as first or second division.

There are three postgraduate degrees offered in science faculties in English universities: the M.Sc. or master of science is awarded for one or two years' full-time research with study of associated fields (at Oxford the B.Sc. is awarded in these cases); the Ph.D. or doctor of philosophy for three to five years of full-time study leading to original research and publication of thesis (at Oxford the D. Phil. is awarded for these studies); the D.Sc. or doctor of science for extensive contribution to knowledge over a period of time as indicated by several original research papers (at Cambridge the Sc.D. is awarded).

Technical Colleges

There are over 400 technical colleges in England[4] concerned with a wide range of technology covering mechanical, electrical, civil, aeronautical, and chemical engineering, architecture, building, textiles, mining, plastics, and other branches of applied science. The colleges vary in size from large colleges of technology (e.g., Manchester) to small technical institutes (e.g., Newton Abbott, S. Devon), but nearly all are maintained by the local education authorities. Some students attend as a condition of their employment (e.g., apprentices) but most students attend by choice on a part-time basis. The fees are low, covering only one fifth of the cost of the courses and some 80% of the work is of a vocational nature. The location of the technical colleges has been dictated very largely by the position of the various industries which have also controlled the development of the colleges to a great extent by the demand they have placed for trained personnel. The studies carried on at the technical colleges vary from preliminary courses for boys and girls of 15 years of age to postgraduate and research work for students many of whom are over 26 years of age. The staffs are both full-time and part-time, the courses being held in the evenings as well as the day time.

College Expansion

The expansion of technical education as a result of the efforts of industry and local education authorities in the period following World War II has overshadowed

Table I. Number of Students in Grant-Aided Establishments of Further Education

	1937-38	1946-47	1954-55
Full-time	20,000	45,000	64,000
Part-time (day)	89,000	200,000	402,000
Evening only	1,094,000	1,166,000	1,575,000
TOTAL	1,203,000	1,411,000	2,041,000

Table II. Percentage of the Population Attending Educational Institutes—General

	Age in Years					
	15	16	17	18	19	20
Boys	75.5	66.2	50.9	31.2	22.3	19.8
Girls	63.8	47.7	33.1	19.2	14.7	12.1

the expansion for any corresponding period.[5] The number of students in grant-aided establishments of further education in England and Wales is shown in Table I.

College Attendance

The percentage of the male and female populations between the ages of 15 and 20 years attending educational institutes is shown for England and Wales in Table II.

In Tables III and IV, these percentages are shown in terms of the percentage attending school, university, teacher training college, full-time, part-time, and evening technical and commercial colleges.

Qualifications

It is possible for students to leave school before 18 years of age and yet still be able to qualify by part-time study for the highest technological qualifications in the country. Leaving school at 15 years of age, a pupil can attend a technical institute for a part-time junior course of one year which will prepare him for starting an industrial (trade) apprenticeship or commercial training at the age of 16 years. Joining other pupils who have stayed at school until 16 or 17 years of age, he can start craft courses leading to industrial qualifications or examinations held by the city and guilds of the London Institute recognized for skilled craftsmen. Alternatively or subsequently, he can enroll for part-time courses leading to technician qualifications such as the Ordinary National Certificate. After successfully passing this stage, the student may start advanced courses which, on a part-time basis, will last from two to four years and will lead to a technologist qualification such as the Higher National Certificate or an external University of London degree. Professional qualifications can be achieved after further study and industrial experience and normally lead to complete qualifications by part-time study at an age of 25 years or more.

If the student wishes to pursue full-time studies, the same technician and technologist qualifications are available, such as the Ordinary National Diploma and the Higher National Diploma. On a full-time basis, it is possible to include a greater content of liberal studies and for this reason the Higher National Diploma covers the full academic requirements for exemption from the examinations of professional bodies, whereas the holders of Higher National Certificates have to spend an additional year or two on extra subjects in order to gain exemption.

Further Expansion

In 1956, the English Government proposed a five-year plan for the further expansion of the technical colleges: The output of students from advanced courses to be increased by half during the five years while the number released by employers for part-time education was planned to be doubled. The present annual output from advanced courses in technical colleges in England and Wales is about 9,500, of whom probably one half qualify eventually as technologists. The proposed increase will provide about 15,000 trained personnel at an advanced level every year and lead subsequently to about 7,000 technologists from this source annually. The expansion policy also includes strong emphasis on the sandwich course method of achieving technologist qualifications. By this method, courses lasting four or five years alternate in periods of three to six months between theoretical education in technical colleges and practical training in industry. It is expected that the majority of students leaving school at 18 and wishing to start a career in industry as soon as possible will choose this method of obtaining advanced technological qualifications as the most appropriate.

Colleges of Advanced Technology

Recognizing that the emphasis on the sandwich course would call for colleges with extensive provision for advanced courses, the English government decided to promote a number of the larger technical colleges to the status of colleges of advanced technology. It was considered advantageous to have teaching staff, technological courses, allied technologies, fundamental sciences, and research facilities at an equally advanced level within the same college for the purpose of effecting the advanced training of technologists. To this end, seven colleges of advanced technology in England have so far been named. They are: Birmingham College of Technology; Bradford Technical College; London: Battersea Polytechnic, Chelsea Polytechnic, Northampton Polytechnic; Loughborough College of Technology; and Salford, The Royal Technical College.

It is proposed that these colleges shall remain within the framework of the local authorities but that the staff shall have appropriate freedom to plan their own courses. They will be expected to develop a substantial amount of research, particularly research sponsored by industry, and, where suitable, to initiate postgraduate studies. It is expected that they will encourage their staffs to undertake a reasonable amount of consulting work and that these extra commitments will probably mean colleges will have to increase their staffs correspondingly.

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National Colleges

Although too minor to justify provision at technical colleges, a few subjects deserved facilities for advanced technical studies. This led the Ministry of Education at the end of World War II to arrange with six industries—foundry, horology and instrument making, rubber, leather, food, and heating, ventilation, and refrigeration engineering—to form a National college for each. Students are sent full-time by the respective industries for periods of study varying from one to two years. The National colleges are financially supported by industry and the Ministry of Education.

Technicians and Craftsmen

In conjunction with the additional supply of highly trained technologists, the numbers of technicians and craftsmen trained every year are to be increased. The traditional method of training technicians and craftsmen in England is the apprenticeship method, the characteristic feature being the practical training received over a period of years. Ability to grasp principles and over-all versatility are keynotes today for those being trained. The fluctuations of the future will make it otherwise

Table III. Percentage of the Population Attending Educational Institutes—Boys

	Age in Years					
	15	16	17	18	19	20
Schools	55.5	17.9	9.6	4.3		
Universities				1.3	2.8	4.5
Teacher Training Colleges				0.1	0.1	0.5
Technical and Commercial Colleges:						
Full-time	1.3	1.4	1.2	1.1	0.9	0.9
Part-time (day)	15.3	21.1	19.3	11.6	8.3	5.8
Evening	25.4	25.8	20.8	12.8	10.2	8.1

Table IV. Percentage of the Population Attending Educational Institutes—Girls

	Age in Years					
	15	16	17	18	19	20
Schools	52.9	16.4	7.6	2.0		
Universities				0.7	1.2	1.6
Teacher Training Colleges				1.5	2.6	1.6
Technical and Commercial Colleges:						
Full-time	2.7	2.5	1.5	0.8	0.5	0.4
Part-time (day)	4.7	5.8	4.8	1.7	0.8	0.5
Evening	23.5	23.0	19.2	12.5	9.6	8.0

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difficult to keep up to date or play an effective part in the industrial picture. Employers in most industries have recognized this and, in nearly all cases, apprentices are released for one day a week for attendance at technical colleges. However, at the present time, there is a serious waste of potential technicians and craftsmen, approximately only 25% completing their training. Most of the waste occurs at the age of 16 and such matters as evening classes, overtime working, being away on a job, shift-work, traveling difficulties, ill health, changing jobs, home conditions not conducive to study, and lack of encouragement from employer are all blamed in this connection. It is considered that a lower rate of waste could be achieved by a greater understanding on the part of the parents and employers, by better selection and, especially, by the substitution of the part-time day for evening classes. It has been shown that the waste from part-time day courses, particularly those attended as part of a formal apprenticeship training, is much less than from evening classes. The local education authorities and industry are consequently being urged to promote study for more boys and girls during the day instead of the evening. The number of students of all ages released from industry in 1954-55 was 355,000. It is the policy in England, at the present time, to double this figure by 1961.

Woman Power

In the USSR, approximately 75% of the medical doctors and about 25% of the technologists are women. However, in England only a few girls leave school and continue their education despite the fact that half of the women between 15 and 35 are gainfully employed. Thus, hundreds of thousands of young women are not making the best use of their talents because their education ceased when they left school. Further education will enable the great number who earn their living to qualify for better jobs and gain the maximum pleasure and profit from their work. If she marries, a girl is likely to educate her own children with ideas drawn from her earlier education and training. Only small numbers of girls at present decide to study science or mathematics at the universities or training colleges and it is hoped that many more may be persuaded to take up these courses in the future.

Conclusions

In England, at the present time, there is a problem in technical education, there are insufficient numbers of adequately trained technical personnel in the country to meet the needs of the manufacturing industry, the government scientific departments, and to staff the universities and the colleges. The production of technologists per million of the population for the whole of Great Britain is less than half that for the USSR, the production of technicians is less than one third of that for the USSR, and only the production of pure scientists is comparable with the Soviet figures (Table V).[6,7,8]

Table V. Technical Personnel Production

	Production: per million population		
Country	Technologists	Technicians	Pure Scientists
Great Britain	121	100	105
United States	136		200
USSR	280	326	56
Western Europe	67		48

Considerable effort is being made to remedy this situation, the universities are doubling their output of scientists and technologists; the technical colleges are expanding to deal with 50% more students at advanced levels, employers are releasing twice as many students for part-time technical courses in working hours, more technicians and craftsmen are being given practical training in industry, and more girls and women are being persuaded to consider technical courses and careers.

There is, in fact, a national effort to safeguard the economic future of the country by active promotion of technical education at all levels. It constitutes an interesting experiment in technical education which may have far-reaching results.

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Syracuse Establishes Semiconductor Laboratory

Syracuse University, Syracuse, N. Y., has established a Semiconductor Devices Measurement Laboratory under the sponsorship of the Electronic Industries Association and the National Electrical Manufacturers Association.

The laboratory, located at the University's Electrical Engineering Research Center, has been set up to aid in the standardization of the description, specification, and testing of transistor and other semiconductor devices.

Purpose of standardization is to help product users select from the nearly 1,000 different types of transistors now manufactured those that best meet their particular needs.

Laboratory director, Dr. R. A. Johnson, associate professor of electrical engineering, explained that laboratory work is centered on conducting scientific investigations necessary for the development of standard methods of test and construction of equipment for making these tests.

Recommendations of the laboratory will be forwarded to the two sponsoring organizations for review and consideration as standards for industry.

Dr. Johnson has been a consultant to both manufacturers and users of transistors and, before joining the University in 1953, was director of transistor research, Transistor Products Inc., Boston, Mass.

Assisting Dr. Johnson at the University laboratory are research staff members, Razendra Nanvati, Robert Gates, and Ralph Wyrick.

Companies Announce Electronic Scholarship

The Ferguson Electronic Supply Company and the Cadillac Electric Supply Company of Detroit, Mich., will grant 2 scholarships to Detroit High School graduates each year (one each semester) with special emphasis in the field of the industrial electronics technician, it was announced recently by Herbert Blumberg, executive vice-president of the affiliated companies.

The scholarship, to be called the "Ferguson Electronic Scholarship," includes one year's tuition, all books and supplies, to the Radio-Electronic-Television Schools located at 3730 Woodward Ave., Detroit, where the student will be working toward a certificate in communications engineering.

Three graduates of the February class recently competed as final candidates for the first "Ferguson Electronic Scholarship." The winner was H. P. Granfeldt of Cody High School.

Sound-Slide Film Program for AIEE Student Branches

The AIEE Student Branches Committee wishes to point out that there is available a sound-slide film program which should be of great interest to all Branches as far as the recruiting of new members is concerned. This program is titled "AIEE and the Young Electrical Engineer," and is actually a program patterned after the speech presented by W. B. Morton, past chairman of the Student Branches Committee, at the 1956 AIEE Summer General Meeting on the advantages to the electrical engineer of joining AIEE. This program should answer many of the questions asked by students with regard to AIEE membership.

The Pennsylvania Power and Light Company has sponsored a program entitled "Electric Utility Engineering a Challenge." This is a discussion of some of the unsolved problems in the electric utility engineering field.

Detailed information on these programs has been circulated to all District Chairmen of Student Activities and it is suggested that they be consulted for information on how to arrange for a showing of these programs.

Prof. Middendorf Awarded NSF Fellowship

W. H. Middendorf, associate professor of electrical engineering in the University of Cincinnati's College of Engineering, has been honored with a science faculty fellowship by the National Science Foundation (NSF).

Under this, Prof. Middendorf will do his predoctoral work in electrical engineering at the Ohio State University, Columbus.

He is a member of Tau Beta Pi, Eta Kappa Nu, Sigma Xi, Electric Circuit Theory Committee of the AIEE, and American Society for Engineering Education.

Prof. Middendorf has served as director, secretary-treasurer, and chairman of the Student Guidance Committee of the Cincinnati section of the AIEE.

Author of a textbook on "Analysis of Electric Circuits," as well as nine scientific papers, Prof. Middendorf has invented 12 devices upon which patents are issued or are pending.

ASEE Electrical Division Meeting at Berkeley, Calif.

Dr. Stuart Johnson, chairman of the Electrical Division of the American Society for Engineering Education (ASEE), has announced plans for the Division's meeting in June at the University of California in Berkeley. Dr. Johnson, who is dean of engineering at Wayne State University, Detroit, Mich., expressed the belief that this year's meeting would be particularly significant for electrical engineering educators because of the unique backgrounds of the participating speakers.

On Tuesday afternoon June 17, a session will be held with the theme "Educating the Electrical Engineer of 1975." Concerned with what needs to be done with present educational programs in electrical engineering to prepare men adequately for professional practice in the next two decades, the program will consist of the following papers:

"The Curriculum Fundamentals," J. R. Whinnery, University of California, Berkeley

"Philosophies of Curriculum Design," Samuel Seely, Case Institute of Technology

"Implementing New Curricula," G. S. Brown, Massachusetts Institute of Technology

The moderator of the session will be Prof. J. H. Mulligan, Jr., New York University, secretary of the Electrical Division.

The program on Wednesday afternoon June 18, will be devoted to the important question of the role that physics should play in electrical engineering curricula. Moderated by Prof. A. V. Eastman, University of Washington, vice-chairman of the Division, the session will contain the following papers:

"An Experiment in the Reduction of Physics Content," J. D. Ryder, Michigan State University

"The Place of Physics in the E.E. Curriculum," T. L. Martin, University of Arizona

"Traditionalism in Undergraduate Physics Teaching," N. W. Harman, Stanford University

On Thursday June 19, the Electrical Division will hold its annual business meeting at which officers will be elected for the next year. A nominating committee of Dr. G. B. Hoadley (North Carolina State) and Dr. A. H. Waynick (Pennsylvania State University) under the chairmanship of Dr. S. R. Warren, Jr. (University of Pennsylvania) has proposed the following slate: for chairman—Prof. A. V. Eastman, department of electrical engineering, University of Washington; for vice-chairman—Dr. J. H. Mulligan, Jr., department of electrical engineering, New York University; for secretary—Dr. W. B. Boast, department of electrical engineering, Iowa State College. Dr. C. R. Vail, department of electrical engineering, Duke University.

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An Electrical Engineer in Industry

R. F. STEVENS (AM '36, M '43), chief of design, Bonneville Power Administration, Portland, Oreg.

Mr. Stevens considers that his membership and activity in the AIEE has been an invaluable aid to his career. "No better way could be found to keep one's own thinking alert than by contact with the best minds in the profession, as they are encountered in AIEE activities. The friendships made with engineers from all corners of the country not only facilitate exchange of information on common problems, but are a great source of personal satisfaction as well."

Mr. Stevens received the B.S. degree in E.E. in 1924 and the professional E.E. degree in 1952 from the University of Washington. Later, as a naval officer during World War II, he attended Princeton and Massachusetts Institute of Technology for radar training. He is now a commander in the U.S. Naval Reserve, and is a member of Tau Beta Pi and Sigma Xi.

Following graduation, he spent one year each on the Westinghouse Graduate Student Course and with the Puget Sound Power and Light Co., Seattle, Wash. The next 12 years were spent with the Seattle Municipal Power System.

Mr. Stevens joined the newly organized Bonneville Power Administration (BPA) in 1938. In 1943, he left to serve three years in the Navy. On his return he was placed in charge of all design work. He has seen the BPA system grow from a few miles of 13-kv line to a network of approximately 7,000 miles of line, including voltages up to 345,000 volts.

Mr. Stevens is the author of several technical papers. He served for a year as secretary-treasurer of the Seattle Section. Since 1949, he has been a member of the AIEE Substations Committee. He served three years as chairman of the Transmission Substation Subcommittee. He has also been a member of three other subcommittees and six working groups, and served as chairman of two of the latter.

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NEC Fellowship Awarded to W. R. Minck

A University of Wisconsin graduate student has been awarded the National Electronics Conference (NEC) fellowship for the 1958-59 academic year.

W. R. Minck, 23, is the winner chosen from national competition. He is currently studying toward his master's degree in electrical engineering, having received his bachelor's degree from the University of Notre Dame.

The fellowship award, worth $2,500, is the second to be given under a program recently adopted by NEC for sponsoring advanced study in electronics, according to an announcement by Dr. E. H. Schulz, conference fellowship award committee chairman.

Mr. Minck plans to use the award for continuing study in the field of high frequency theory and techniques at the University of Wisconsin.

The NEC fellowship is given for a year of graduate study at any one of the nine colleges and universities co-operating in the Conference. These include: Illinois Institute of Technology, Northwestern University and University of Illinois as sponsors. Michigan, Michigan State, Notre Dame, Purdue, Wayne State, and Wisconsin Universities are participating institutions.

Other sponsors of the Conference are the AIEE and Institute of Radio Engineers; the Electronic Industries Association and Society of Motion Picture and Television Engineers are also participants.

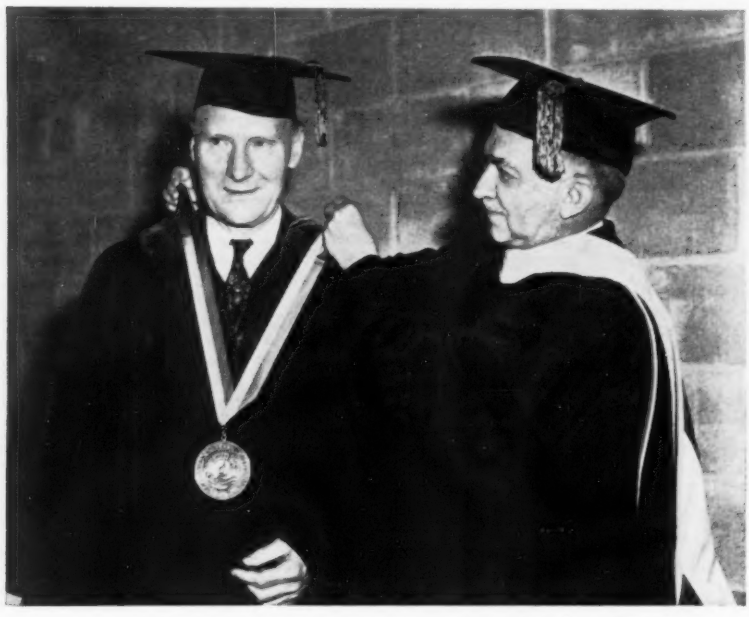
Dr. Weber Inaugurated as President of Polytechnic Institute of Brooklyn

IMPRESSIVE CEREMONIES marked the inauguration of Dr. Ernst Weber as sixth president of the Polytechnic Institute of Brooklyn. Rogers Hall was dedicated in memory of the late Dr. Harry Stanley Rogers. Five honorary degrees were conferred and an address was given by H. G. Rickover, Rear Admiral, USN. Official delegates attended from practically all the great institutions of higher education.

The ceremonies opened with the presentation of colors, singing of the National Anthem, and the invocation given by the Reverend Bishop H. G. Welch. Greetings were expressed by P. R. Bassett, chairman of the Polytechnic Corporation, who drew attention to the 1954 Centennial and the vision of the late Dr. Rogers in the building program.

An address, "Harry Stanley Rogers," was given by Dr. L. W. Houston, president emeritus of Rensselaer Polytechnic Institute, and a lifetime friend. Dr. Houston paid tribute to Dr. Rogers' vision of greatness and his philosophy of education. Through his leadership, Polytechnic Institute of Brooklyn gained rank and prestige as one of the largest progressive engineering schools in the country.

Following the address, a bronze plaque was unveiled by Mrs. Grace L. Rogers in memory of Harry Stanley Rogers to be mounted in the hall of the new building which bears his name.



P. R. BASSETT *(right)*, chairman of the board of trustees, invests Dr. Ernst Weber *(left)* as sixth president of the Polytechnic Institute of Brooklyn. Dr. Weber wears Polytechnic's Seal as a symbol of his office.

Admiral Rickover's Address

An address, "The Truth Shall Make You Free" by H. G. Rickover, Rear Admiral, USN, compared European educational standards with those in America. The Admiral warned that the lead time for the production of military hardware might be too great, due to over organization. In Europe, educational standards are set at a national level through a ministry of education; whereas in this country, they are set by several hundred different Boards of Education. While, in general, higher education was satisfactory, the secondary school education was considered by Admiral Rickover to be deficient, requiring additional time to be made up at the college level.

Inaugural Address

The inaugural address by Dr. Weber was built around the quotation, "Knowledge is proud that he has learned so much; Wisdom is humble that he knows no more." The philosophy of an engineering and scientific education was pointed out by Dr. Weber, who cited the objectives as well as the obligations of the faculties. He said that the greatest contribution to science was the printing of books and nothing since has contributed so much. The 19th Century is considered as the Steam Era, the 20th the Electrical Era, and the 21st will be the Nuclear Energy Era. The steady flow of continuing evolution was considered by Dr. Weber important in the development of the scientist rather than dates, names, and so forth. He believed it was important for the scientist to know the fine arts and also important that those liberally educated should know the scientists' search for the truth. (The full text of Dr. Weber's inaugural address will appear in the July issue of *Electrical Engineering*.)

In introducing the speaker, Dr. Bassett explained that a number of candidates were considered but none measured up to the qualifications of Dr. Weber, who had been affiliated with the Polytechnic Institute of Brooklyn for 27 years and who was formerly vice-president of research. He also knew the philosophy and ideas of Dr. Rogers very well and had served as acting president.

Conferral of Honorary Degrees

The degree of doctor of engineering was conferred on E. E. Kleinschmidt, inventor of teletypewriter, and on H. G. Rickover for his leadership in the development of the atomic submarine. The doctor of laws degree was conferred on S. M. Tucker, emeritus head of the Polytechnic English Department; His Honor R. F. Wagner, Jr.,

and Herbert George Welch. The Reverend Bishop Welch was Methodist Bishop Emeritus of Japan and Korea and, at 96, is Polytechnic's oldest alumnus. The first Polytechnic medal for distinguished service was awarded to J. R. Brierley, who in a large measure was responsible for the foundation of the Polytechnic Alumni Association. At the conclusion of the ceremonies, luncheon for the faculty and guests was held in Rogers Hall.

Course in Quality Control by Statistical Methods at Purdue

An advanced short course in Quality Control by Statistical Methods will be held at Purdue University for the 12th year in succession under the direction of Prof. I. W. Burr, June 10-20, 1958. This is one of two such advanced short courses, the other being offered at University of California at Los Angeles, now in its third year.

In recent years the Purdue course has drawn its limit of 50 enrollees each year from the East and Middle West. This popular, intensive short course is designed for those who have a background in control charts and acceptance sampling. The statistical techniques presented are of value to research workers as well as those concerned with quality of production.

The subjects covered in the 10-day period include significance tests and estimation, linear and multiple correlation and regression, single and sequential sampling for measurements, and analysis of variance.

A brochure of this short course explaining several of the industrial and research applications of the techniques which are taught may be had by addressing Prof. I. W. Burr, Statistical Laboratory, Purdue University, Lafayette, Ind.

New Meeting Place for Illinois Tech Student Branch

The AIEE Student Branch at the Illinois Institute of Technology has acquired a new meeting place—the spacious 350-seat auditorium of the recently completed electrical engineering-physics building.

Having such a large meeting place presents a challenge to fill the auditorium by offering interesting programs. A full schedule of events which was outlined included a student papers contest, a field trip to Western Electric's Hawthorne Works in Chicago, Ill., and guest speakers on fields such as ferrite cores and nuclear power.

The first meeting of the Spring semester was a membership meeting. Lending an official note to the meeting were two members of the Chicago Section of AIEE. R. B. Gear, who will shortly assume the position of Institute vice-president for the Great Lakes District, and E. C. Medal, chairman of the Chicago Section Student Activities Committee, spoke on AIEE structure and activities with an emphasis on Student Branches.

The Chicago Section works closely with the Student Branches in sponsoring Student Night dinners, field trips, and student papers competitions.

Summer Engineering Courses at the University of Michigan

The following intensive courses for scientists and engineers and business and management will be conducted by the College of Engineering at The University of Michigan during the 1958 Summer Session. Advance registration is required.

Names and dates of the courses are: "Technical Writing," June 16-20; "Automatic Control," June 16-25; "Applied Machineability," June 16-27; "Introduction to Digital Computer Engineering," June 16-27; "Advanced Theory of Logical Design of Digital Computers," June 16-27; "Introduction to Standard Methods of Numerical Analysis," June 16-27; "Advanced Numerical Analysis," June 16-27; "Computer Programming and Artificial Intelligence," June 16-27; "Introductory Survey of Operations Research and the Management Sciences," June 16-27; "Foundations and Tools for Operations Research and the Management Sciences," June 16-27; "Business-Type Data Processing: Recent Development and Future Trends," June 16-27; "Gas Turbines and Free Piston Engines," July 7-11; "Advances in Design and Operation of Distillation and Absorbtion Equipment," July 7-16; "Engineering Approach to Surface Damage," July 14-19; "Dynamics of Flight," September 8-13.

Further information on the courses may be obtained from the Co-ordinator of Engineering Summer Conferences, 2038 East Engineering Building, Ann Arbor, Mich.

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Dudley Observatory First To Offer Public Membership

Recognizing the growing significance of the new Age of Space and the widespread popular interest which it has stimulated, the trustees of Dudley Observatory, Albany, N. Y., have decided to make the Observatory the first in the United States to be open to public membership, it was announced recently by Dr. R. P. Baker, president of the board.

This decision, Dr. Baker revealed, will be carried out by the creation of a new organization, The Friends of The Observatory. A membership drive covering the entire Albany area as well as outlying areas of New York State, began on May 6.

Membership privileges in the new organization, Dr. Baker said, will include attendance and participation in specially arranged programs, as well as use of various Observatory facilities.

Financial support received from Friends of The Observatory will, in turn, enable the Observatory to increase significantly its public and educational services and also its research activities. The latter have been seriously curtailed as a result of rising post-war operating costs.

Some of the specific advantages to be offered the Friends of The Observatory are: (1) four special Members' Nights at the Observatory featuring talks on popular

TWO OFFICERS of the Chicago Section of AIEE were on hand to start the Spring semester Student Branch activities at the Illinois Institute of Technology on the occasion of the Branch's first meeting in a new, modern electrical engineering–physics building. G. C. Vandling *(left)*, Student Branch chairman, points out a highlight of the Branch's tentative program to *(left to right)* E. C. Medal, chairman of the Chicago Section Student Activities Committee; B. A. Fisher, Student Branch advisor; and R. B. Gear, AIEE vice-presidential nominee for the Great Lakes District.

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astronomical topics by prominent speakers; (2) special Family Nights with programs exclusively for members and their families; and (3) A subscription to *The Griffith Observer*, a monthly publication on amateur astronomy.

Individual family, business, and organization membership fees range from $10 to $100 per year. In addition, a special annual educational membership for science teachers will be offered for $5, and persons may become life patron members for $1,000.

Public desire for a research center in Albany led to the chartering of The Dudley Observatory, a nonprofit organization, in 1852. In 1873, Dudley Observatory became associated with Union University, which today is comprised of Union College, Albany Medical College, Albany Law School, Albany College of Pharmacy, and the Observatory.

Microwave Course at Case Institute of Technology

A summer study course in microwave theory and technique, including the widespread use of radar by the military and in the transportation industries, is being offered August 4-15 at Case Institute of Technology.

Directed toward the engineer in industry who has found a growing need for training in the methods of measuring and analyzing with microwaves, the short course will be directed by Dr. Beaumont Davison, assistant professor of electrical engineering. The series of lectures and laboratory sessions will be conducted on the advanced graduate level, and background requirements for engineers wishing to take the course should include college-level studies in a-c circuits and elementary electron tube circuits, as well as mathematics through differential equations.

Requests for additional information on the microwave course should be addressed to The Director of Special Programs, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.

Conference on Utilization of Scientists and Engineers

A prediction that job opportunities for technical manpower, which have remained "relatively stable" during the current recession, will be increased sharply by midsummer, and proposals for making fuller use of the existing supply of engineers and scientists were offered for top-management consideration recently.

The manpower utilization proposals, drawn up in five panel discussions on the Rutgers University, New Brunswick, N. J., campus, were presented to 100 delegates at the closing session of the New Jersey Conference on Utilization of Scientists and Engineers, April 2-4.

The highlighted proposals were:

1. Industry should seek support for legislation which would provide New Jersey with a technical institute. There is no local source, it was said, from which New Jersey industry can draw certified technicians.

2. Research scientists and engineers should be paid for potential—for what they are capable of doing as well as what they are being called on to do.

3. A good salary ranks first or very high among the ideal job conditions desired by most technical personnel in New Jersey, despite contrary findings in national surveys. Members of the panel considering problems of classification and compensation, who represented a cross-section of industry in this state, said surveys in their plants disputed the statistics of another speaker who claimed salary followed "challenging work" and "advancement opportunities" in the ideal job situation.

4. Efforts should be made to improve methods for selecting and training scientists and engineers. Planned programs should be developed in both areas for the ultimate benefit of the manpower team and the plant.

5. Industry has a responsibility to assist in guidance programs of community high schools.

6. The highly creative engineer or scientist needs freedom of expression, unobstructed communications between members of his team and professional recognition on the job.

W. T. Cavanaugh, executive secretary of the Engineering Manpower Commission of the Engineers Joint Council, told a luncheon meeting that 1958, in terms of job opportunities for technical manpower, most likely will be the opposite of 1957, a year which began high and ended in a relative decline.

Citing as yet unpublished figures obtained from the U. S. Employment Service, Mr. Cavanaugh said there has been a sharp reversal since early February in the engineering index, which, he said, "has been gently declining for the past year." He said the figures show that the total number of engineering jobs handled by the U.S. Employment Service has increased 57% since February 1, and that the same trend has occurred in openings for physical scientists.

"The recruitment of new and recent engineering bachelor of science graduates can be more productive during the next few months in terms of both quality and quantity and in almost all curricula than during any period since early 1950 despite the fact that the level of demand is still relatively high," Mr. Cavanaugh said.

Dean E. C. Easton of the Rutgers College of Engineering, the Conference chairman, presided over the wind-up session in the Engineering Building at which the five panel chairman presented recommendations drawn up in day-long conclaves.

The panel chairmen, and their discussion topics, were: F. D. Leamer, personnel director of Bell Telephone Laboratories, New York, N. Y., methods for making maximum use of the creative potential of scientists and engineers; Dean J. C. Elgin, Princeton University College of Engineering, selection and training of scientists and engineers; L. H. Good, director of engineering utilization for Radio Corporation of America, Camden, N. J., maximizing the performance of the manpower team; Julius Hannoch, executive director of administration for Merck & Company, Rahway, N. J., problems of classification and compensation; and T. V. Reinauer, chief engineer, Pulverizing Machinery Division of Metals Disintegrating Co., Elizabeth, N. J., education and utilization of technicians.

L. R. Merrill, dean of faculty at Stevens Institute of Technology, Hoboken, N. J., opened the second day's program. Herbert Wottrich of Public Service Electric & Gas Co., Newark, N. J., was chairman of the general session. The remainder of the day was devoted to the panel discussions.

M. D. Hooven, past president of AIEE and president of the Engineers' Council for Professional Development, was chairman of the luncheon session.

Full-Year Course in Russian at Harvard

A new full-year language course in elementary Russian will be offered at Harvard University this Fall, primarily in response to requests from students in the sciences.

"This new course is in addition to the intensive, one-semester Russian course now offered," said H. G. Lunt, associate professor of Slavic Languages and Literatures, who will teach the course.

Prof. Lunt said that the new course will give the student a vocabulary of about 1,500 words and a working knowledge of Russian grammar. A vocabulary of at least 3,000 words is needed for literary reading.

"With this course, a student in science and mathematics should be able to get through Russian scientific publications with the aid of a dictionary," he said.

Recent Engineering Faculty Appointments

Washington State College, Pullman. Dr. E. W. Greenfield (F '51) was named as director of the Division of Industrial Research in Washington State College's Institute of Technology. Dr. Greenfield leaves the position of research supervisor of the department of metallurgical research for Kaiser Aluminum & Chemical Corporation, Spokane, Wash. He is expected to start his new duties on June 1.

Michigan State University, East Lansing. Dr. Lawrence Von Tersch has been appointed head of the department of electrical engineering at Michigan State University. Dr. Von Tersch will continue as director of the computer laboratory. A member of the Michigan State faculty since March 1956, he has been acting head of the department of electrical engineering since October 1957.

Pratt Institute, Brooklyn, N. Y. C. C.

Carr (AM '30), professor of electrical engineering and chairman of the department of electrical engineering of the Pratt Institute Engineering School, has been named assistant dean of the Engineering School. Prof. Carr has been a member of the Pratt Institute faculty since 1920 and has been head of the electrical engineering department since 1938. He is a member of the American Society for Engineering Education.

Ohio State University, Columbus. Dr. G. B. Carson, dean of the College of Engineering at Ohio State University since 1953, has been appointed vice-president, business and finance. H. A. Bolz, associate dean of the College of Engineering, was named to serve as acting dean until a successor to Dr. Carson is appointed.

"Engineers' Week" at University of Louisville

Prominent among the events of "Engineers' Week" at the University of Louisville, Ky., April 14-19, 1958, was the dedication on Monday afternoon of the new civil and electrical engineering building, W. S. Speed Hall. Dedication ceremonies included an address by Dr. F. L. Wilkinson, Jr., president of Rose Polytechnic Institute, on "Modern Trends in Engineering Education."

On Monday evening, Dr. M. D. Hooven, president of Engineers' Council for Professional Development and past president of AIEE, delivered the First Annual Alumni Distinguished Lecture on "The Engineers' Responsibility for Intellectual Development."

Other activities of "Engineers' Week" included the Engineering Counseling Convocation for High School Students, Engineers' Day Exhibition, and Engineers' Ball.

"Do I Have Engineering Aptitude?"

The pamphlet, "Do I Have Engineering Aptitude?" which includes a set of questions, answers, and interpretations of answers for use in self-analysis by young men and young women 16 to 25 years of age, is now available in quantity. These may be obtained at $2 per package of 50 from Engineers' Council for Professional Development, 29 W. 39th St., New York 18, N. Y.

Approximately 20,000 copies of an earlier version of this pamphlet have been distributed, upon request, by the New Jersey Engineers' Committee for Student Guidance. Because of the large number of requests, the committee has been forced to limit its bulk distribution to New Jersey.

Individual editors, engineers, principals, or guidance counselors who request a copy of the pamphlet upon their official letterheads and who enclose a stamped, self-addressed, size 10 envelope will be sent a complimentary copy.

The author, Dr. A. P. Johnson, assistant director of the Counseling Center at Newark College of Engineering, himself an engineering graduate and an experienced psychologist, was formerly project director for engineering tests at Educational Testing Service, Princeton, N. J.

Tau Beta Pi Fellows for 1958-59

Five young engineers have been selected by Tau Beta Pi National Engineering Honor Society for graduate fellowship awards in 1958-59. The five men are:

L. E. Strawbridge, Felton, Pa.—Honeywell-Tau Beta Pi Fellow No. 5. Will graduate in electrical engineering from The Pennsylvania State University in June 1958. Will take advanced work in nuclear engineering at Massachusetts Institute of Technology next year.

J. L. Dodd, Aberdeen, Miss.—Charles H. Spencer Fellow No. 3. Will graduate in electrical engineering from Mississippi State College in June 1958. Will take advanced work in electrical engineering and communications at Mississippi State College next year.

Peter Briggs, Middletown, N. Y.—Tau Beta Pi Fellow No. 138. Will graduate in mechanical engineering from Rensselaer Polytechnic Institute in June 1958. Will take advanced work in mechanical engineering either at Rensselaer or at Massachusetts Institute of Technology next year.

F. S. Hillier, Aberdeen, Wash.—Tau Beta Pi Fellow No. 139. Will graduate in industrial engineering from Stanford University in June 1958. Will take advanced work in operations research at Stanford University next year.

L. C. Lynnworth, Brooklyn, N. Y.—Tau Beta Pi Fellow No. 140. Will graduate in electrical engineering from New York University in June 1958. Will take advanced work in electrical engineering at Stanford University next year.

These five awards by Tau Beta Pi's Fellowship Board bring the total to 147 fellowships granted since the program was inaugurated in 1929. Stipends for this group are $1,500 each for the nine-month academic year. Over $129,000 in fellowship stipends will have been awarded by Tau Beta Pi in the 29-year-old program when this new group completes its graduate work in 1959.

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Seminars at Pennsylvania State University

The annual three-day Seminar on Electrical Contacts, to be conducted by the Pennsylvania State University's department of electrical engineering and General Extension, with co-operation from Stackpole Carbon Company and other manufacturers and users of electrical contacts, will be held June 16-18. R. E. Armington, associate professor of electrical engineering, is chairman of this seminar which will be of particular interest to practicing engineers, physicists, and research scientists working in the areas of heavy current and sliding electrical contacts. Further information may be obtained from Prof. Armington, 104 Electrical Engineering Building, The Pennsylvania State University, University Park, Pa.

An Engineering Seminar on Automatic Controls will be offered by the University August 3-8. The course is primarily for engineers and scientists whose work requires a broad understanding of the application of feedback control to industrial processes and product operations, as well as a familiarity with modern techniques

Increase in Earned Degrees in Science and Engineering

Dr. Herbert Conrad, of the Office of Education, has furnished the Engineering and Scientific Manpower *Newsletter* with information on degrees earned in institutions of higher learning in academic year 1956-57. The figures reveal substantial increases throughout the entire higher educational field, and particularly in the fields of science and engineering.

In the fields of science this represents an increase of 11%, as compared with 9.3% in all fields of learning, and for the first time the increase in the number of master's degrees granted is measurable and significant. In no field has there been a meaningful change in the number of doctorates granted.

Earned Degrees, 1955-56 and 1956-57

	Bachelor		Master		Doctor	
	1955-56	1956-57	1955-56	1956-57	1955-56	1956-57
All fields	311,298	340,347	59,370	61,955	8,815	8,756
Agriculture	7,286	7,943	1,467	1,549	398	353
Biology	12,566	13,868	1,759	1,801	1,022	1,103
Mathematics	4,660	5,546	892	965	224	249
Physical sciences	11,672	12,934	2,640	2,704	1,635	1,674
Psychology	5,665	6,191	969	1,095	632	550
[SUBTOTALS]	41,849	46,482	7,727	8,114	3,911	3,929
Engineering	26,312	31,211	4,724	5,233	610	596
TOTALS	68,161	77,693	12,451	13,347	4,521	4,525

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in the analysis and design of control systems. Additional information may be obtained from the Extension Conference Center, The Pennsylvania State University, University Park, Pa.

Closed-Circuit Television at the New York Trade School

The New York Trade School (NYTS), New York, N. Y., oldest institution of its kind in the country, unveiled a new development in closed-circuit educational television during a recent regional meeting of the United States Office of Education in New York City.

Representing about a year's work by electronics teachers and students of the NYTS, the new system is unique in educational television and already has attracted the interest of groups like the American Management Association, the U.S. Navy, and the National Association of Manufacturers.

Observers from these and other organizations were on hand when educators from the North Atlantic Region of the U. S. Office of Education moved their sessions to the school on April 15 for a first-hand look and demonstration.

For the last five years, the NYTS has been working closely with the Electronics Industries Association, studying new closed-circuit television equipment and preparing instructional materials that are used in more than 300 cities.

Now the school has developed and is using a system of its own, with added features it believes are important advances over television teaching techniques in general use.

With its new television setup, the NYTS can move a portable studio into any laboratory or shop in the four-story building. So far as industry experts know, it is the only mobile studio that has been developed for educational television.

"You can't take an automobile or a printing press into a classroom," says G. E. McLaughlin, superintendent of the school, "but you can get it there on a television screen."

Another new feature of the NYTS program promises to be of equal or even greater importance in classroom and similar uses of closed-circuit television. The school has built a two-way intercom system into its portable studio, so that students at any time may question the remote lecturer, and he in turn can explain whatever points are not clear.

The audio "feedback" feature is also extremely rare in educational television.

Actually, the NYTS' system has three-way communication. When two or three classes are watching the same demonstration from separate viewing rooms, questions asked by students in one of the classrooms can be heard in all rooms, as well as by the remote lecturer. The teacher's answer also goes to all the viewing rooms.

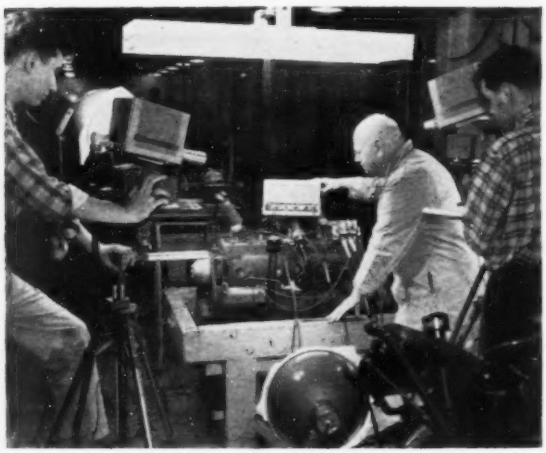
Students of the NYTS operate the cameras and serve as the television "engineers." They also did most of the installation work for the new system. Supervising the project were Paul Zbar, head of the television department; his assistant, Sid Schildkraut, and William Vanderbeek, assistant superintendent.

Outlets have been installed on each floor for plugging in the television power, audio and video. Attached to the portable studio is a drum with a 150-foot cable, which lets the studio move to any corner of the building. The adjuncts to the studio are also portable. Students have mounted the cameras and lights on platforms on wheels.

Mr. McLaughlin sees many useful applications of closed-circuit television to education at all levels, and in each case believes that the ability to ask questions and receive answers step by step is of prime importance if the technique is to have the greatest possible value. He cites these as possibilities:

(1) Demonstrations in college science laboratories, where there is more than one class but only one set of equipment available.

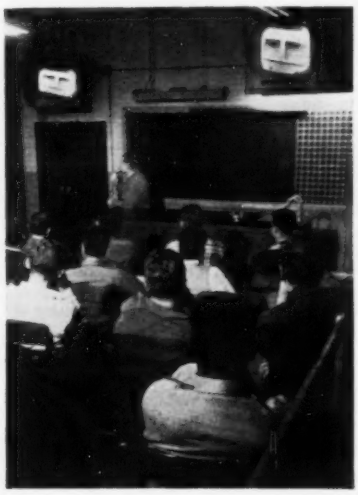
(2) Work which must be witnessed by



CLOSED-CIRCUIT television takes a New York Trade School class into the automotive shop where W. C. H. Meyer, head of the automotive department, demonstrates a voltage-regulator check. Students Robert Niefeld (*left*) and Denis Mahoney (*right*) serve as cameramen.

◄ A FEW FEET away from the lecturer, student J. J. Tiesler operates the controls of the school's portable studio.

► IN A CLASSROOM on another floor, students all have "front row" seats for the demonstration. Camera concentrates on close-up of a meter, where readings show the result of the voltage-regulator check. Instructor is Arthur Richards.



the student for effective teaching, such as procedures used by surgeons and dentists, in the medical and dental schools.

(3) Training of many kinds both in the armed forces and industry.

(4) Shop and lab demonstrations in trade schools like his own or in high schools.

He is not convinced that television is ideally suited for much regular classroom and lecture-type teaching—unless it becomes mandatory from a lack of qualified teachers.

Colleges To Get Reactor Simulators

A nuclear reactor simulator having the "feel" of costly research reactors will be supplied by Minneapolis-Honeywell Regulator Co. to four United States universities.

The schools—University of West Virginia, University of Minnesota, University of Oklahoma, and Wayne State University in Detroit—will use the simulators to train prospective nuclear engineers in all phases of reactor operation, the company said.

The simulator, developed by nuclear engineers of Honeywell's Industrial Division, is a console-type unit incorporating a working full-scale model of an automatic control system for power and research reactors and an electronic computer circuit that artificially recreates a reactor's operational characteristics.

With the simulator, the company explained, electrical signals can be generated similar to those obtained from sensing elements in a nuclear reactor. Interchangeable plug-in circuitry permits simulations of either U-235, U-233, or plutonium fuel. The simulated signals are amplified, recorded, and automatically controlled with the same instruments used on real reactors. The control system has a control permit circuit that prevents switching to automatic control unless the power level is within 10% of the control setting. Range of the simulator is 0-150% of reactor design power.

Georgia Tech's Radioisotopes and Bioengineering Laboratory

At a special morning ceremony, ground was broken on March 27, at the Georgia Institute of Technology, Atlanta, for the $600,000 Radioisotopes and Bioengineering Laboratory building.

Pres. E. D. Harrison officiated in the brief outdoor ceremony. Short addresses were given by Gov. Marvin Griffin and F. H. Neely, chairman of the Georgia Nuclear Advisory Commission.

The new laboratory building, expected to be completed in the Spring of 1959, will contain about 16,000 square feet of area devoted to research and educational facilities. It will provide Georgia Tech with a central service for the handling and storage of radioisotopes, and it will furnish facilities for graduate students and staff members to engage in research involving radioisotopes and neutrons.

Special provisions of the new laboratory will include Georgia Tech's subcritical assembly and a one-million volt Van de Graaff accelator as well as specific areas devoted to subjects such as the biological effects of radiation and airborne bacteria. About 60% of the new building is devoted directly to radioisotopes and nuclear physics applications in educational research. The other 40% will be devoted to biological research.

The laboratory was financed through an initial grant of $300,000 from State surplus by Gov. Marvin Griffin and through subsequent grants of $125,000 by the National Institute of Health and $69,500 from the Georgia State Board of Regents. Equipment grants totalling over $250,000 have already been received by Georgia Tech from the U.S. Atomic Energy Commission for use in this new laboratory building.

Special areas in which the building will be used for education and research include: radiation chemistry, radiochemistry, nuclear chemical engineering, radiation biology, engineering materials in nuclear engineering, nuclear physics, neutron and reactor physics, aerobiology, and public health.

The building was designed by Atlanta architect, J. W. Cherry.

Bell Telephone Laboratories Announces Fellowship Winners

The names of 14 nation-wide winners of its 1958-59 university graduate fellowships were announced recently by Bell Telephone Laboratories, research and development organization of the Bell System. Outstanding students working toward doctor of philosophy degrees in sciences relating to communications were selected for the annual awards.

Each Bell Laboratories Graduate Fellowship carries a grant of $2,000 to the recipient and an additional $2,000 to cover tuition, fees, and other costs at the college he has selected for his doctoral work.

The recipients of the fellowships will do their advanced graduate studies at 13 universities across the nation. The winners were selected by a committee of distinguished scientists and engineers at Bell Laboratories.

Physics students predominate with seven winners among the group; three are electrical engineers, two are physical chemists, and two will study mathematics.

During the three years in which fellowships have been granted by Bell Laboratories, a total of 39 outstanding college graduates have received the grants. A total of 49 fellowships have been awarded; 10 individuals have been named twice.

Six winners are being honored a second time this year with the fellowships. These six, their home towns, the universities they attend, and their fields of specialization are: S. H. Glarum, Wyncote, Pa., Brown University, physical chemistry; Eugene Levine, Brooklyn, N.Y., New York University, higher algebra; Bede Liu, New York, N.Y., Polytechnic Institute of Brooklyn, active networks (electrical communications); W. A. Mehlhop, Hamburg, Germany, Washington University at St. Louis, Mo., beta and gamma ray spectroscopy; W. H. Orttung, Narberth, Pa., University of California, electrical and optical properties of macromolecular solutions; and Sukeyasu Yamamoto, Tokyo, Japan, Yale University, experimental nuclear physics.

The eight other fellowship winners, their home towns, the schools they have selected for their advanced studies and their fields of specialization are: Manuel Cardona, Cadiz, Spain, Harvard University, semiconductors; R. N. D'heedene, New Vernon, N. J., Harvard University, applied mathematics; H. D. Helms, Winnetka, Ill., Princeton University, communication and information theory; Jagadishwar Mahanty, Cuttack, India, University of Maryland, solid-state physics; Ivars Melngailis (AM '56), Pittsburgh, Pa., Carnegie Institute of Technology, semiconductors at low temperatures; G. E. Smith, Upper Darby, Pa., University of Chicago, experimental solid-state physics; D. W. Tufts, Boston, Massachusetts Institute of Technology, mathematical aspects of communication theory; and K. G. Wilson, Concord, Mass., California Institute of Technology, theoretical physics.

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Booklet Describes Wheelabrator Fellowship

Details of the Wheelabrator Fellowship program are available in an eight-page brochure published by the Foundry Educational Foundation (FEF). The Wheelabrator grant will enable the FEF to award 50 fellowships of $1,500 each during the next 10 years. The grants are available for advanced study in science, business, and engineering related to the cast metals industry. Persons currently employed in the cast metals industry are among those eligible.

Complete information can be obtained by writing either to the Foundry Educational Foundation, Terminal Tower Building, Cleveland 13, Ohio, or to Wheelabrator Corporation, 400 S. Byrkit St., Mishawaka, Ind.

Statistical Summer Seminar

The ninth session of the Statistical Summer Seminar will be held July 28 through August 8, 1958, at the Massachusetts Institute of Technology Endicott House, Dedham, Mass. This seminar is a private, nonprofit organization dedicated to exploring new areas of applications in statistics. It is sponsored by the Office of Naval Research.

The program is as follows:

July 28-August 1, "Tolerance Management" with Dr. Emmanuel Davis, General

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Electric Company, as program chairman.

August 4-8, "Design of Industrial Experiments" with Dr. M. B. Wilk, Bell Telephone Laboratories, as program chairman.

Each session will have one or two speakers a day as discussion leaders. It is felt that this arrangement will provide an unhurried atmosphere to foster an exchange and growth of ideas. Familiarity through study and work in the previously stated statistical fields or professional competence in the field of application is assumed, as discussions will be at a fairly sophisticated level.

The registration fee which covers all living expenses is $150 for each session. Grants-in-aid are available for educators and Government workers.

Further information may be obtained from Irving Weiss, Bell Telephone Laboratories, North Andover, Mass.

Department of Nuclear Engineering Announced at MIT

A department of nuclear engineering, to educate students in the peaceful application of atomic energy, is to be established at the Massachusetts Institute of Technology (MIT), Dr. J. A. Stratton, acting president, has announced. Dr. Manson Benedict, professor of nuclear engineering, has been appointed head of the department.

The $2.64 million nuclear reactor at MIT, which was being completed this Spring, is to serve as a laboratory for the new department, enabling students to make first-hand studies of atomic energy produced by the fission process. However, subjects taught will include fusion, the nuclear reaction which occurs in the sun and stars and which is regarded as an inexhaustible power source for the future.

The department, first in any New England college and one of the first in the United States, is the outgrowth of several years of experience in nuclear engineering at MIT. It will be a Division of the School of Engineering, of which Dr. C. R. Soderberg is dean. The teaching program will dovetail with a research program, which will include studies of atomic energy for medical and industrial as well as scientific purposes.

In the next two years, the demand for engineers and scientists in atomic energy work will nearly double, Dean Soderberg said. He referred to a survey, made in 1957 for the Atomic Energy Commission by the Atomic Industrial Forum, showing that about 9,000 scientists and engineers were employed by industry in privately supported atomic energy activities. By 1960, industry expects to need 16,000.

"Not only is there a rapidly increasing demand, but there is an exceptional demand for men of high abilities," Dean Soderberg said. "Nuclear engineering is a complex subject and requires competence in physics, chemistry, metallurgy, chemical, electrical, and mechanical engineering, and other fields. At MIT we hope to train the men who will be leaders in atomic energy."

The first course in nuclear engineering was offered at MIT in 1952 and since that time other courses have been developed, under the leadership of the head of the department of chemical engineering, Dr. W. G. Whitman. Meanwhile, there has been expansion in such fields as experimental physics and theoretical physics, important in the education of students interested in atomic energy. There is also research work in fusion, such as that being conducted by Prof. W. P. Allis and in the work conducted through Project Ashby.

The new MIT reactor is not designed for the generation of power, being a "cool" one intended only for research, teaching, and medical therapy. However, students receiving degrees in the new department will be prepared for professional work in designing and operating power reactors, among other things.

In addition to classes in Cambridge, nuclear engineering students may attend the Engineering Practice School conducted by MIT at Oak Ridge, Tenn.

Study in the new department will require prerequisites of physics, mathematics, and engineering, Dean Soderberg said. Classes will be open to undergraduates but the department will give degrees only for graduate work. Establishment of the department will be effective July 1, 1958.

Professor Benedict, who will head the new department, joined MIT in 1951 at the time a decision was made to enter the field of nuclear engineering. He was joined in 1955 by Dr. T. J. Thompson, who has directed the design and construction of the MIT reactor. Other members of the new department will include Dr. Irving Kaplan, Dr. E. A. Mason, Dr. Melville Clark, Jr., and Dr. Gordon Brownell.

Summer Course in Scientific Russian

Carnegie Institute of Technology (CIT) will offer a summer course in Scientific Russian in answer to increasing needs of graduate students and research workers, Pres. J. C. Warner announced recently. It will be specially designed for graduate students in engineering and science, but may be taken by others as well.

Scientific Russian, according to the professor, Dr. Emanuel Salgaller, stresses a quick acquisition of reading knowledge in technical literature, with speaking and writing instruction deferred to advanced courses. Dr. Salgaller, a native of Latvia, believes that progress in technical Russian can be made as quickly as in German, in spite of the widespread feeling that Russian is more difficult.

The 18-unit course, equivalent to a full year of work, will meet for two hours each morning Monday through Friday from June 16 to August 9. No previous language training is required. A similar course in Scientific German, taught by Prof. Fred Genschmer, head of the department of modern languages, will meet during the same hours. CIT offers courses in Beginning and Intermediate Russian during the regular school year.

Fellowships Awarded by AEC

A total of 165 young college graduate students from throughout the United States will be engaged in conducting advanced studies in nuclear science and engineering next year, under fellowships which have been awarded them by the U.S. Atomic Energy Commssion (AEC).

Four of the newly appointed fellows are in their third year of graduate study, 45 are second-year graduate students, and the remaining 116 are embarking on their first year of advanced work.

The Oak Ridge Institute of Nuclear Studies (ORINS), which administers this special graduate fellowship program in nuclear science and engneering for the AEC, has announced the selection of the 165 fellows for their outstanding academic achievements from among more than 400 applicants. Final decision as to the appointments was made on the recommendation of a board composed of representatives of educational institutions, industry, the AEC, and ORINS.

The nuclear science and engineering fellowship program was established by the AEC to encourage more students at the graduate level to pursue courses of study in the physical sciences and nuclear-energy technology, with particular emphasis on reactor engineering and development. Fellowship appointees select one of 39 colleges or universities that have been designated by the AEC for participation in the program.

A broad curriculum outline has been prescribed for the fellows, designed with sufficient flexibility to permit the university to which each student is assigned to determine his particular course needs, within a program of study in nuclear science and engineering. The fellowships are awarded for one year of study.

MISTIC Plays "Waltzing Mathilda"

The versatile MISTIC (Michigan State Integral Computer) now plays "Waltzing Mathilda."

The special tape that causes the big computer to air the Australian Army song was given to Dr. J. D. Ryder, dean of Michigan State University's College of Engineering, by operators of MISTIC's "sister" at the University of Sydney, Australia.

During his recent Australian visit, Dean Ryder made arrangements with University of Sydney computer experts for a mutual exchange of computer information and operating instructions.

The MISTIC music vaguely resembles that of a group of bagpipes. It is made

by the computer's audible signals, which ordinarily tell the operator how the machine is functioning. MISTIC "thinks" it is working a mathematical problem.

As Dr. Ryder said, "the music illustrates the versitility of computers and the men who run them."

As is MISTIC, the University of Sydney machine is based on ILLIAC (University of Illinois automatic computer). The Sydney machine is the SILLIAC. Another computer based on the ILLIAC is being built at Iowa State College.

Since the four machines are so similar, Dean Ryder believes that sharing of information will be mutually advantageous to the universities.

Anchor Metals To Award Annual College Scholarship

A four-year college scholarship in engineering will be awarded to a senior student at Lawrence Bell High School at Hurst, Texas, by Anchor Metals, Inc., of Hurst, beginning this year, Anchor Metals President C. F. Mooney has announced.

The scholarship, worth $2,900, will be awarded each year to a student of good standing who has had four years of mathematics and four of science and who has shown aptitude in those subjects, Mr. Mooney stated.

Names of three qualified students will be submitted to Anchor officials by a committee composed of administrators and teachers from Bell High School and the choice announced by May 1 of each year.

The winner may attend any college in the United States that offers an accredited four-year course leading to a bachelor's degree in engineering. He will be expected to work at Anchor Metals for practical experience during vacations from college. Following graduation, the winner will be encouraged to work full time for the company.

Professor Envisions Electrical Examination Machine

A glorified "pinball" type machine with its own electrical brain system may someday replace the professor in the college examination room, according to one educator at Union College, Schenectady, N. Y.

H. W. Bibber, professor of electrical engineering at the old upstate New York school, envisions an electrical examination machine which can be set up to administer exams of the objective or multiple choice type and perhaps, depending on the extent of its "brain system," even handle problems of a more complex nature. The student, Prof. Bibber said, would merely step up to the machine at exam time, read his question, push the proper buttons or pull the proper handles, and wait for the machine to register his score.

Prof. Bibber is completely serious about his brainchild and outlined his plan in detail in the recent winter issue of *Bridge*, quarterly publication of Eta Kappa Nu, national electrical engineering honor society. In the same article, he advocated greater use of closed-circuit television in the lecture hall, including film-taped lectures.

The examination machine, Prof. Bibber said, would save many valuable hours of instructor time, which is now spent in proctoring and correcting examinations, and it would also give the student an immediate evaluation of his proficiency.

In addition, it would be a major step away from the intellectual "spoonfeeding," which is so characteristic of the present day educational system. The student would be placed in a position where he could check his own progress, and decide for himself when he needed further review or additional examinations. "The country will lose a few engineers who might have been brought to graduation," Prof. Bibber said in explaining this type of academic philosophy, "but it will gain in the greater self-discipline of those who do graduate, and in the economy of the educational process."

The need for such instructional innovations, Prof. Bibber indicated, is being brought on by at least four factors: demand for higher quality engineering graduates, increased need for engineers to pursue graduate study, increased cost of securing teaching faculty in engineering schools and the resultant necessity for larger classes, and the coming increase in the number of college age students.

In actual practice, Prof. Bibber said, the "pinball" examination machine would be a far cry from the four-legged plywood monster commonly found in the corner cigar store, although some concession in the form of flashing lights or clanging bells might be made to the student who scores a perfect grade on his exam. Two things are certain, however: "Body English" wouldn't help anybody beat this gadget; and if the machine registers "Tilt," young Johnny had better have a good story ready for the home folks.

Spokane Section Meets with Student Branches

DURING the Tri-Sectional Meeting of the AIEE Spokane Section with the AIEE Student Branches from the University of Idaho, Moscow; and Washington State College, Pullman (above, *left*) Charles Uhden (*left*), chairman of the Student Activities Committee of the Spokane Section, presents check for first prize in the student paper competition to D. P. Merriam (*right*), Washington State College. Mr. Merriam's paper was entitled "A Kinetic Transducer." Above, *right:* R. C. King (*left*) of the University of Idaho, is congratulated on winning second prize in the student paper competition by Mr. Uhden. The Tri-Sectional Meeting was held March 28, 1958.

OF CURRENT INTEREST

Courtesy Handy-Boesser Photographers

"FINGERPRINTS" of an unknown chemical mixture are examined by IT&T engineers Ronald Taplin (left) and Mortimer Rogoff on automatic electronic spectroanalyzer punched paper tape that records the absorbance of infrared waves, a quality as unique to chemicals as fingerprints are to humans.

Spectroanalyzer Obtains Rapid Chemical Data on Substances

AN ELECTRONIC spectroanalyzer that promises to speed medical research by shortening to minutes the time required to measure hormones in complex chemical mixtures is being developed by the International Telephone and Telegraph Corporation (IT&T), it was disclosed today.

A classical problem in many fields of analysis is that of reducing a complex mixture containing many elements into its constituent parts. The analytical information required is the identity of the individual parts, and the amounts of each that are present.

New Technique

When a large number of elements exist the analysis cannot be performed by ordinary methods. The new FTL technique has been named Electronic Spectroanalysis and in one of its first applications has been applied to the chemical analysis of steroid compounds, in co-operation with the Sloan-Kettering Institute for Cancer Research.

Now being tested in the IT&T Federal Telecommunications Laboratories (FTL), the new analyzer, which "marries" the sciences of infrared spectroscopy and electronic data processing, is scheduled for delivery in the Fall to Sloan-Kettering scientists who participated in early stages of its development.

Design and operation of the electronic analyzer and the nature of the research problems to which it will be applied were discussed before the recent national convention of the Institute of Radio Engineers in New York, N. Y. Mortimer Rogoff, executive engineer of Federal Telecommunication Laboratories, IT&T research division, and Dr. T. F. Gallagher, of the Sloan-Kettering Institute, presented a joint paper on the project.

Time Element Cut

The device not only does in minutes analyses that now require days and sometimes weeks, but it measures the quantity of hormones in chemical mixtures so complex that they would not ordinarily have been analyzed by present methods of infrared spectroscopy because the time required is prohibitive, it was stated.

The analyzer is expected to aid medical investigations, and have numerous applications in chemical, petroleum, pharmaceutical, and nuclear research.

"Its speed will serve to make scientific manpower more effective by freeing researchers from time-consuming techniques in chemical analysis," stated Henri Busignies, president of the IT&T laboratories, who initiated the analyzer development project.

Accumulation of a great number of biochemical "portraits" of people taken at frequent intervals in their lives would provide a valuable field for medical researchers. Present cumbersome and unwieldly methods of chemical analysis rigorously limit collection of such a series of portraits, but the new electronic analyzer promises to accelerate laboratory work and thus yield a much greater amount of data for such investigations.

One of the principal time advantages of the new system of electronic analysis is that the various components of a chemically involved sample need not be isolated before they are subjected to infrared photometry, but can be handled "in a lump."

Description

The spectroanalyzer system consists of: (1) a spectrophotometer which sends infrared rays and measures their absorptions, (2) a recording device which encodes the data in numerical form on paper or magnetic tape, (3) a "library" containing on the same kind of tape the infrared absorptions of possible constituents, and (4) a high-speed electronic computer to perform the mathematical calculations resulting in quantitative analysis of the sample under examination.

The analyzer works in the following way. The fluid, or chemical mixture being analyzed, is "illuminated" with infrared waves. The spectrophotometer records the

selective absorption of infrared energy and this information is transmitted to the tape. The measurements are automatically compared with the other tapes in the library and the exact quantity of each constituent in the mixture is computed electronically. By elimination, an unknown constituent may be detected and identified.

Many Uses

The spectroanalyzer can also be readily adapted to the analysis of nuclear radiations. Atomic research has produced literally thousands of samples of radioactive isotopes, mixtures of which would require several days of analysis by highly skilled scientists to be identified properly. The IT&T device, on the other hand, would put the "finger" on the unknown chemicals quickly and easily.

The data processing portion of the system might also be employed to speed such scientific method of analysis as vapor phase chromatography, a technique used in the analysis of gases; X-ray spectroscopy, to pinpoint the concentration of elements in metals and ceramics, and in mass spectroscopy.

Mixtures with up to 10 constituents can be analyzed easily. The spectroanalyzer records the entire infrared spectrum of the mixture and employs that whole spectrum in a high-speed electronic matching technique. This is in contrast to the older method of matching spectra at just a few wavelengths.

The new research tool identifies organic chemicals by a quality or property as unique to each chemical as fingerprints are to the individual. This quality is the tendency of each compound or chemical mixture to absorb a distinct amount of infrared radiation at particular wavelengths.

Infrared is the heat-wave portion of spectrum—the same spectrum that includes X-rays, radio waves, and light. Each compound selectively absorbs energy throughout the infrared spectrum depending upon the nature of its components. The electronic spectroanalyzer mathematically determines what components comprise the mixture of the chemicals being analyzed.

The greater sensitivity of the device, obtained by measuring virtually the entire infrared spectrum, makes it invaluable where only a trace of a constituent exists.

For nuclear research, the spectroanalyzer can be adapted to identify radioactive isotopes by the number of electrons or atoms given off, an identifying mark as certain as the degree of infrared absorption.

The great accuracy of IT&T's development may be attributed to the measurement of the infrared readings at 3,000 different points of the spectrum—a vast departure from former methods in which perhaps only half a dozen points were noted.

Georges Deschamps and Ronald H. Taplin, IT&T senior project engineers, aided Rogoff in the work on the new analyzing system.

Courtesy Handy-Boesser Photographers

INFRARED HEAT WAVE amounts absorbed by a chemical mixture are examined before the information is used in an electronic spectroanalyzer, a device to identify chemicals automatically. The FTL developed instrument speeds identification of body hormones for the Sloan-Kettering Institute for Cancer Research.

Dead Sea Scrolls Indexed by Computer

INTERPRETATION of the controversial Dead Sea Scrolls, the most exciting Biblical find in centuries, was brought many years closer with the recent printing of the first complete index of a major portion of the 2,000 year old documents by an International Business Machines (IBM) *705* electronic computer.

"Scholars all over the world who have been seeking since the Scrolls were discovered for a more complete knowledge of these fragments, have now been given a most valuable tool," Professor James Muilenburg of the Union Theological Seminary, noted Biblical scholar and a leading authority on the Dead Sea manuscripts, said at a special demonstration for the press at the New York headquarters of IBM.

An index is a standard device used to break down a written work alphabetically into words, so that any given one may be studied in all of its contexts. New words come into a language and old words gradually change their meanings. Scholars can translate accurately only by having the exact context for every instance a word appears.

The scholar's task in studying the Dead Sea Scrolls is unusually difficult because of their deterioration. Not only are many words and portions of words missing, but entire sections have crumbled to dust. Thousands of small fragments were found on the floors of caves, and these phrases, words and even characters must be identified and fitted into the proper Scroll like a giant jigsaw puzzle. The machine-made

Future Meetings of Other Societies

SNAME, Spring Meeting, June 2-3, Hotel Chamberlin, Old Point Comfort, Fort Monroe, Va. SNAME, 74 Trinity Pl, New York 6, N. Y.

American Nuclear Society, 4th Annual Meeting, June 2-5, Statler Hotel, Los Angeles, Calif. R. L. Loftness, Atomics International, P. O. Box 309, Canoga Park, Calif.

The Institute of Radio Engineers

2nd National Symposium on Production Techniques, June 5-6, Hotel New Yorker, New York, N. Y. W. E. Vannah, Control Engineering, 330 W 42 St, New York, N. Y.

2nd National Convention on Military Electronics, June 16-18, Sheraton Park Hotel, Washington, D. C. George Rappaport, Emerson Radio & Phonograph Corp, 1140 East-West Hwy, Silver Spring, Md.

EEI, 26th Annual Convention, June 9-11, John Hancock Hall, Boston, Mass. EEI, 420 Lexington Ave, New York 17, N.Y.

The American Society of Mechanical Engineers

Materials Handling Conference, June 9-12, Public Auditorium, Cleveland, Ohio. Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Semiannual Meeting, June 15-19, Statler Hotel, Detroit, Mich. L. S. Dennegar, ASME, 29 W 39 St, New York, N. Y.

4th International Automation Exposition, June 9-13, New York Coliseum, New York, N. Y. International Automation Exposition, Richard Rimbach Associates, 845 Ridge Ave, Pittsburgh 12, Pa.

NSPE, Annual Meeting, June 11-14, Chase-Park Plaza Hotels, St. Louis, Mo. K. E. Trombley, NSPE, 2029 K St, NW, Washington 6, D. C.

The Patent, Trademark, and Copyright Foundation, Annual Public Conference, June 19-20, Sheraton-Park Hotel, Washington 8, D. C. PTCF, George Washington U, Washington 6, D. C.

AIChE, 50th Anniversary Meeting, June 22-27, Philadelphia, Pa. J. I. Savoca, Socony Mobil Oil Co, Paulsboro, N. J.

ASTM, 61st Annual Meeting, June 22-27, Hotels Statler & Sheraton-Plaza, Boston, Mass. A. L. Batik, ASTM, 1916 Race St, Philadelphia 3, Pa.

ASHAE–ASRE, Joint Meeting, June 23-25, Minneapolis, Minn. ASHAE Hq Leamington Hotel; ASRE Hq Nicollet Hotel. E. R. Searles, ASRE, 234 Fifth Ave, New York 1, N. Y.

ASCE, Convention, June 23-28, Portland, Ore. D. Reynolds, ASCE, 33 W 39 St, New York 18, N. Y.

SPI, Midwest Section Conference, June 26-27, French Lick-Sheraton Hotel, French Lick, Ind. L. P. Williams, SPI, 250 Park Ave, New York 17, N. Y.

Foreign

CIGRE, 17th Biennial Session, June 4-14, France.

7th International Inventors Exhibition, June 6-29, Belgium.

International Organization for Standardization, Triennial Meeting, June 9-21, England.

5th International Electronic & Nuclear Energy Exposition & Congress, June 16-30, Rome, Italy.

International Electrotechnical Commission (IEC), Annual meeting, July 1-16, Stockholm, Sweden.

2nd International Conference for Analog Computations, Sept 1-7, Strasbourg, France.

2nd International Conference on Peaceful Uses of Atomic Energy, Sept 1-13, Geneva, Switzerland. U.N.O.

2nd International Congress on Cybernetics, Sept 3-10, Namur, Belgium. Secretariat, International Association for Cybernetics, 13, rue Basse-Marcelle, Namur, Belgium.

ICAS, 1st International Congress of the Aeronautical Sciences, Sept 8-13, Madrid, Spain. Institute of the Aeronautical Sciences, 2 E 64 St, New York 21, N. Y.

2,000 YEAR OLD column from "Manual of Discipline" scroll (*extreme left*) shows omissions and editor's corrections contributing to indexing and analyzing difficulty. Word 7 of line 14 (*arrow*), chosen at random, illustrates steps in mechanized processing. Original Hebrew translation reads: "as it is written, 'In the wilderness prepare the way of the LORD! *make straight* (*circled word*) in the desert a highway for our God'." The word "Lord" is represented by four dots—considered too sacred to spell out. Published scroll (*center left*) is marked by scholars to prepare text for machine processing. Markings show location of each word and its relationship to other words, phrases, paragraphs, and ideas. Arrow points to word 7 line 14, and handwritten numerals indicate number of words per line. IBM cards (*center right*) represent 10 words of line 14. During preliminary indexing stages, each word of entire document was punched on an IBM card. Information was then transferred to magnetic tape for 705 computer processing (arrow indicates word 7). Word list section (*right*), printed in Hebrew, shows word 7 line 14 (*arrow*) in alphabetic order in scrolls dictionary, together with original location information.

index will be of enormous assistance in this task, enabling the scholar to see at a glance every possible use of each fragment.

FACSIMILE of a Dead Sea Scroll manuscript is examined at the console of the IBM *705* electronic computer by Fr. Roberto Busa, Jesuit scholar, and Paul Tasman, IBM World Trade Corporation, while the machine processes index of the ancient religious writings.

By transposing prose into a series of mathematical relationships, the IBM *705* is capable of making a qualified guess as to what words were originally written in the hundreds of mutilated sections. The computer analyzes the words preceding and following each gap. Thousands of words are then electronically scanned until the computer finds one that most nearly fits into the context. To determine the accuracy of this technique, portions of a familiar text were blocked out and fed to the machine. This experiment proved that the computer could replace correctly as many as five consecutive words. The *705* can also reveal a mathematical picture of different styles of writing, detecting additions by another hand foreign to the original author.

IBM machines were first used for literary analysis in 1949 to help compile the first concordance of the complete works of St. Thomas Aquinas. Developed jointly by Father Roberto Busa of the Jesuit College of the Aloisianum in Gallarate, Italy, and IBM engineer, Paul Tasman, the new method proved so successful that it was decided to apply it to the urgent task of cataloging the many scrolls and fragments found in the Dead Sea caves.

The first step in preparing the index was to reduce the nearly 30,000 words under study to IBM cards. This was done under Father Busa's supervision at the Literary Data Processing Center in Gallarate. A card was punched for each word, indicating its exact location (scroll, column, line, and sequence), and its distinguishing characteristics. The entire set of cards was then sent to New York where the data was converted to two reels of magnetic tape by the IBM *705* computer in approximately two hours. The final alphabetical summary lists were printed in Hebrew by the *705*'s printing unit at the rate of 150 lines a minute.

Discovery and Background

The first scrolls were found in 1947 by Bedouin herdsmen in a cave in Jordan, near the west coast of the Dead Sea. The cave is within a mile of the ancient ruins of Khirbet Qumran, believed to be the site of a monastery or group of communal dwellings. After the original discovery of seven scrolls enclosed in jars, other scrolls and thousands of fragments were found in the vicinity.

The Scrolls were written or copied between the second century B.C. and approximately 150 A.D., according to archeological evidence and paleography.

COMPARING words of a modern "scribe"—IBM *705* printing unit—with those written 2,000 years ago by ancient Hebrew sect scribes is Fr. Roberto Busa. With the help of IBM engineers, Fr. Busa pioneered machine analysis of literary and religious works.

On-the-Wall Television Progress

An experimental television display screen—brighter than any previously reported and no thicker than a picture frame—has moved the idea of "television-on-the-wall" a step closer to reality. The new display screen is an important step in efforts to replace the bulky, high-

vacuum television picture tube with a flat, bright solid-state display screen.

Developed by scientists at the Westinghouse Research Laboratories, Pittsburgh, Pa., the new display is called an Elf screen, getting its name from two words: electroluminescent and ferroelectric. It combines in a simple structure an electroluminescent panel—man's newest source of light—and a flexible, built-in storage and control structure made of ferroelectric materials.

In describing the development, Dr. E. A. Sack, manager of the dielectric devices section of the Laboratories declared, "A satisfactory solid-state display screen is an important objective of modern electronics research. When such a screen is fully developed, it will do such things as display radar pictures or other information in aircraft, show the ever-changing air traffic pattern around an airport, or bring on-the-wall television to the average American living room. Recent progress in the development of bright and efficient electroluminescent phosphors leads us to believe that they offer the best approach to such a flat, efficient solid nonvacuum state display."

The Elf screen overcomes the problems of low brightness and excess flicker by providing for continuous—not interrupted—excitation of the screen. The built-in ferroelectric cells store and control the information to be displayed. They distribute excitation to the screen in accordance with an applied electrical charge. Once this charge distribution is established, the screen is excited without interrupting throughout the complete frame, or picture. Then the charge distribution is changed to form a new picture.

Present experimental models of the Elf screen are less than a quarter-inch thick and have a brightness three times that of a conventional television screen. The contrast ratio between light and dark areas of the screen is as high as 200 to 1.

There are no inherent limitations of the size of the glowing Elf screen, in fact, with appropriate electroluminescent panels a display the size of a window would be easier to construct than one the size of the usual television picture tube.

Dr. Sack said that a practical form of the Elf screen was still in its early stages of development, with commercial screens several years away. A practical screen, is fabricated by preparing a laminated "sandwich" of electroluminescent and ferroelectric layers which have been divided into the many separate components required to produce a detailed picture. Coarse displays of this type have been made experimentally.

"The one outstanding feature of the cathode-ray tube which will not be easy to duplicate is the ease of scanning, or signal distribution, inherent in the tube," Dr. Sack declared. "We now regard this as the major problem to be overcome in perfecting the Elf solid-state screen. Continuous excitation of the screen by means of a system of storage and control was the obvious first step toward a successful device. Now we are attacking the problem of distribution of signal information, which is done so capably by the scanning beam in the cathode-ray tube.

"We cannot say how soon this phase of work will graduate from its early research stages. Ultimately, we feel sure the problem will be solved, and the Elf screen well may be the long-sought on-the-wall television display."

In Orbit and Reporting Regularly

EXPLORER III, the third Army-launched United States scientific earth satellite was fired into orbit around the Earth on March 26, 1958, by use of a Jupiter C rocket developed and launched jointly by the U. S. Army Ballistic Missile Agency (ABMA), Huntsville, Ala., and the California Institute of Technology Jet Propulsion Laboratory (JPL), Pasadena, Calif.

Explorer II was launched March 5, 1958 but did not achieve orbit.

The third satellite, fired into orbit by the Army while Explorer I (launched January 31, 1958) still circled the Earth transmitting information to ground stations, weighs slightly more than Explorer I which weighed 30.8 pounds.

Explorer III, weighs 31.00 pounds, or 0.20 pounds more than Explorer I, is approximately 80 inches long, and has a nominal diameter of 6 inches.

Accounting for the difference in weight is the different instrumentation in the third satellite, which includes a magnetic tape recorder to collect and store on its "memory" information on cosmic rays throughout its entire orbit.

JPL and ABMA collaborated in firing Explorer I, the first successful United States earth satellite, from the Missile Test Center, Cape Canaveral, Fla.

The third Army-launched satellite was launched while Explorer I was some distance away in its orbit. The danger of the two satellites colliding was so remote as to be termed a billion-to-one chance.

The payload instruments in Explorer III weigh 10.83 pounds, as opposed to a weight of 10.63 pounds for instrumentation in Explorer I. The thin steel case into which the instruments are packed weighs 7.5 pounds, bringing to 18.33 pounds the weight of the instrument-carrying portion of the satellite.

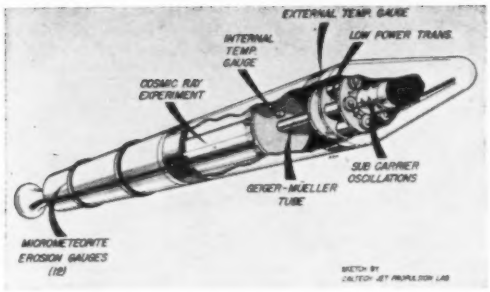
The two transmitters in Explorer I telemetered measurements of cosmic ray intensity, two measurements of micrometeorite impact (an erosion grid and an impact microphone), and inner and skin temperatures of the satellite. Explorer I also had a nose-cone temperature sensor to measure the aerodynamic heating of the nose cone during the launch phase. This information was transmitted continuously by both transmitters.

In Explorer III, only the low-power transmitter sends information continuously on external and internal temperatures, one measurement of micrometeorites (the spring impact microphone has been eliminated), and cosmic ray counts. The high-power transmitter is equipped with a tape recorder and a memory unit that is interrogated by a command radio signal from the ground as it passes over the Minitrack receiving net. The high-power

SATELLITE PROJECT key figures at JPL are: *(left to right)* Geoffrey Robillard, chief of solid rocket section; Dr. H. F. Richter, Jr., research group supervisor; Mrs. Phyllis Buwalda, research analysis section; and W. K. Victor, chief of electronic research section. Mr. Robillard is holding an igniter for a solid rocket, on the table in front of Mrs. Buwalda is the low-power transmitter, and Mr. Victor is holding the high-power transmitter package which includes the magnetic tape recorder.

Comparison of the U.S. Army IGY Satellites

Dimension	Explorer I	Explorer III
	Pounds	*Pounds*
Weight	30.80	31.00
Shell	7.50	7.50
Instrumentation	10.63	10.83
Final rocket (empty)	12.67	12.67
	Inches	*Inches*
Length	80	80
Diameter	6	6
High-Power Transmitter		
Power	60 mw	60 mw
Frequency	108.03 mc	108.03 mc
Life expectancy	2 weeks	2 months
Low-Power Transmitter		
Power	10 mw	10 mw
Frequency	108.00 mc	108.00 mc
Life expectancy	2 months	2 months



EXPLORER III, U. S. Army's third satellite, is shown in artist's sketch. The turnstile antenna was eliminated from this satellite.

transmitter sends only information on cosmic rays.

The final-stage rocket motor, exclusive of the solid-propellant fuel which gave it the final acceleration into orbital speed of slightly more than 18,000 miles an hour, weighs 12.67 pounds.

ABMA was responsible for the operation and launching of the first stage, a liquid-propellant rocket using a Redstone propulsion system. JPL was responsible for the high-speed stages, the satellite, the satellite data-gathering and observation activities, the rocket motors, and the solid-fuel propellant. Cooper Development Corporation, Monrovia, Calif., made the rocket-motor cases to JPL specifications.

Before the Jupiter C rocket left the ground, the high-speed stages were set spinning by electric motors, which in flight eventually whirled them around at a rate of more than 700 rpm. This was done in order to stabilize the flight attitude and to minimize the danger of one rocket in the set of clusters throwing the satelite off course by burning at a different rate.

Dr. W. H. Pickering, director of JPL, and Dr. J. E. Froelich, JPL satellite project director, revealed that Explorer III has a different antenna for its high-power radio than that used in the two earlier Army satellites, which used a turnstile antenna consisting of four whip-like wires,

ALUMINUM OXIDE STRIPS, used to keep temperatures within a certain range, have not been added to satellite in this early stage being inspected by *(left to right)* John Small; Dr. J. E. Froehlich, Explorer III project director for California Institute of Technology; Dr. A. R. Hibbs; Karl Linnes; and Walter Victor.

each 22.5 inches long, extending from a Fibreglas ring in the midsection to serve as antenna for the high-power transmitter in the satellite.

The decision to eliminate this turnstile antenna and to replace it with a dipole antenna—in which the satellite itself is the antenna—is an example of how Explorer I contributed to knowledge of space conditions, or lack of conditions. It also provides an insight into some of the complexities of the satellite project.

The nose of the satellite is striped with aluminum oxide which runs the length of the instrument carrier. There are eight equally spaced stripes $\frac{1}{4}$ inch wide covering approximately 25% of the steel surface which serve to keep the temperature of the satellite interior within a reasonable range. For the welfare of the instruments, it is important to know and control the movement of the satellite when it is broadside to the sun because during this period the metal absorbs heat which it radiates into space when it moves around to the shade side of the Earth. Too much exposure to the radiant heat of the sun, for example, would perhaps result in the melting of the electronic components; too little heat absorption might make the satellite radiate heat into dark-side space to such an extent that the instruments might freeze.

JPL scientists prepared the external striping so successfully for Explorer I that the interior temperature was held to within 43 to 104 F. The same striping was used on the third satellite.

The tracking and receiving telemetry data from Explorer I indicated that the satellite flight attitude may have been affected in such a way by the protruding antenna as to cause the satellite to revolve slowly in a propeller-like fashion in its orbit. Small motions or wiggles in the antenna wires apparently were transmitted to the body of the satellite by friction, causing a damping effect which affected the satellite by starting a slow oscillation around its short axis. This oscillation gradually took on the form of a propeller-like twist that apparently occurred in a 7-second cycle.

To eliminate this probable cause of oscillation, it was decided to abandon the turnstile antenna and substitute the dipole antenna for the high-power transmitter in Explorer III. This system is achieved by using the satellite itself as an antenna. The same gap also serves as the antenna for the radio receiver accepting the coded ground signal to activate the magnetic tape recorder and the high-power transmitter.

JPL and the ABMA, under command of Maj. Gen. J. B. Medaris, joined in this launching as part of the IGY activities, which are sponsored by the National Academy of Sciences.

Dr. Pickering described the instrumentation in Explorer III as "more sophisticated" than the instruments in the Explorer I. These Explorer III instruments, Dr. Pickering explained, include a magnetic tape recorder which receives total omnidirectional cosmic ray incidences and intensities throughout the satellite orbit.

The ingenious miniature tape recorder —the size of a king-size cigarette package —gives the United States IGY earth satellite the ability to provide five times the information on cosmic ray intensities as was furnished by Explorer I.

Two miniaturized transmitters in the third satellite collect and transmit information on three experiments: cosmic rays, temperatures of the surface and interior, and micrometeorites. Then, as the satellite swings over the Minitrack ground network along the 75th meridian in North and South America, it is interrogated by a radio command signal from the ground which tells it to report what it has found in its orbit.

In some 5 seconds, the playback head of the miniature recorder cascades down to ground stations with special equipment a veritable torrent of information that it has picked up during the 2 hours or more of its flight, by use of a special radio signal coded as to frequency and duration. The tape recorder contains some 55 inches of magnetic tape on which the cosmic-ray levels are imprinted. This is the equivalent of some $2\frac{1}{4}$ hours of flight time.

After the reception of this rapid-fire signal on the ground, the information is passed through special filters to reduce the background noise. Then translated in the form of visual lines on an oscilloscope to sort out the information in its code.

The tape recorder to give 100% information on the cosmic rays was proposed to the U. S. IGY Committee, for use in a satellite, by Dr. J. A. Van Allen, head of the physics department at the State University of Iowa (SUI).

This Van Allen experiment, modified to eliminate the tape recorder, was contained in Explorer I. The third Army satellite contains the true Van Allen package, including the tape recorder, slightly modified by the JPL.

George Ludwig, a graduate physics student at SUI and an assistant to Dr. Van Allen now assigned to JPL, helped design the tape recorder package and modify it for installation in the cylindrical shell case of Explorer III which contains the instrumentation. The tape recorder is in an encapsulated unit which also holds the high-power transmitter that radiates 60 milliwatts of rf energy.

The high-power transmitter is on the air only during the time that it is relaying the coded information on the magnetic tape to the ground. This conservation of the chemical batteries is expected to prolong the life of the high-power transmitter to two months. The high-power transmitter sends only information on cosmic ray activity.

The low-power transmitter in Explorer III radiates 10 milliwatts of energy and has a life expectancy of two months. It

sends continuous transmissions to ground stations on the external and internal temperatures of the satellite, cosmic ray counts, and micrometeorite impact.

The micrometeorite experiment, responsibility of Dr. Edward Manning of the Air Force Cambridge Research Center, gives figures on the density and relative momentum of the tiny, dust-like cosmic particles as they hit a 12-wire grid erosion gauge mounted near the aft end of the satellite. Connected in parallel, to operate a subcarrier of the low-power transmitter. As each wire grid is severed, the subcarrier will experience a small step change in frequency, indicating a high-velocity impact with a micrometeorite five microns or larger.

The capsule has a tuning fork which gives an internal time standard. This standard is used to relate the incidences and intensities of cosmic rays to points where they occurred in the orbit. In recording cosmic rays in flight, the tape recorder moves at a snail's space—5/1,000 inch per second.

Because it will thus give complete information on cosmic ray levels during its entire orbit, Explorer III is expected to produce some new scientific evidence relating to the geomagnetic fields.

It is known, for example, that cosmic rays are more intense at the North and South Poles of the earth, where there is also greater concentration of magnetic lines which influence the cosmic rays. Whether or not this phenomenon is related exclusively to the magnetic core of the earth, or is influenced by some outside factor, is a disputed question.

There is one theory that a belt of ionized particles is traveling in a ring outside the earth's atmosphere to form a current and induce a magnetic field that is independent of the earth's magnetic field. Some preliminary evidence as to the validity of this theory may be furnished by the cosmic ray data gathered.

"White Alice" Network in Operation

A NEW, 3,000-MILE telephone and telegraph network was put into full operation on March 26, 1958, to provide both military and public service to some of Alaska's most remote northern points.

The U. S. Alaskan Air Command formally accepted the "White Alice" network at a ceremony at Elmendorf Air Force Base. Telephone calls were placed over the system to its most distant points—including Cape Lisburne, on the northwest tip of North America; St. Lawrence Island, in the Bering Sea, and Wales, only 50 miles from the coast of the USSR.

Speakers at the ceremony stressed the significance of the completed network to the development of the nation's "last frontier." It was predicted that Alaska's first widespread communications network will be both a stimulant and unifying force.

Construction began in 1955 for the network that was delivered to the Air Force by the Western Electric Company, prime contractor for White Alice.

White Alice is the Air Force code name for the network, which operates by means of a new form of radio relay, and is bringing reliable communication for the first time to many cities and towns in the distant regions of Alaska.

It ties together radar warning outposts of the Alaskan Air Command, and also connects to the Alaskan segment of the Distant Early Warning (DEW) Line along the northern rim of the continent. In addition to serving the Air Force, the network also provides circuits for the Army and Navy, the Civil Aeronautics Administration, and the people of Alaska.

Some communities' only contact with the outside world was by "bush radio." These are now receiving their first reliable telephone and telegraph service through White Alice. The new network is not affected by weather or atmospheric interference, which previously have hampered communications in the Far North.

Service is also being made available between communities on the White Alice network and points in the United States through the Alaska Communication System and the Bell System.

White Alice is the largest telephone system to use the new over-the-horizon method of radio relay, which employs huge antennas, resembling outdoor movie screens. The antennas send signals up to 170 miles between stations in a single hop. This development in transmission made possible construction of the network in Alaska, where vast stretches of forbidding terrain and savage winter storms have ruled out conventional wire and radio relay routes.

About 3,500 persons from all parts of the United States and Alaska took part in construction of the network. To relay the messages, 33 stations were built—many of them on mountain tops that at first could be reached only by plane or helicopter, and later had to be leveled off to make room for the stations. Air strips were built to receive cargo planes and access roads constructed.

Telephone men from many of the Bell companies volunteered to work on the project with Western Electric, the Bell System's manufacturing and supply unit. They selected the station sites, camped out for weeks while conducting the first tests, and installed the transmitting and receiving equipment.

There are 28 stations that are manned by permanent crews of technicians employed out of the 33 stations set up by the Federal Electric Corporation, which operates the network for the Alaskan Air Command. At remote sites the crews live in well-equipped dormitories, attached to the stations.

Travel Grants Provided by NSF

The National Science Foundation is authorized to provide a limited number of travel grants to assist qualified physical scientists, mathematicians, and engineers who wish support to attend international meetings concerned with subjects in the physical sciences.

Applications for financial support should be submitted prior to June 30th

WHITE ALICE NETWORK dish antenna (*right*), one of two types used in the over-the-horizon system set up in Alaska for better communications throughout the Territory. Scoop antenna (*left*), 60 feet tall and resembling outdoor movie screen, is second type used. Antenna positions and alignments had to be precise in order to direct radio beam to topographically hidden station which picked it up out of the troposphere scatter.

for travel between October 1, 1958, and March 31, 1959. And applications must be received before December 31st for travel to be performed between April 1, 1959, and September 30, 1959.

Requests for applications should be addressed to the Assistant Director for Mathematical, Physical, and Engineering Sciences, National Science Foundation, Washington 25, D. C.

Hot Laboratories Division Solicits Conference Abstracts

The Hot Laboratories Division of the Brookhaven National Laboratory would appreciate the early receipt of abstracts of papers that are to be presented at the 7th Conference on Hot Laboratories and Equipment. The abstracts are due September 15, 1958, at the latest.

These should be sent to the program chairman, L. G. Stang, Jr., Brookhaven National Laboratory, Upton, N. Y.

The deadline for the papers themselves will be announced later.

Papers are invited on all phases of hot laboratories and equipment for handling radioactive material including design, construction, operation, maintenance, decontamination, remodelling, shielding calculations, costs, etc.

The Conference will be held April 1959 in Cleveland, Ohio.

Cameras Pave Way for *F-101* Voodoo Speed Records

Careful preliminary photographic studies laid the groundwork for the series of four speed records set by the U.S. Air Force in December 1957 in McDonnell *F-101* Voodoo jet aircraft.

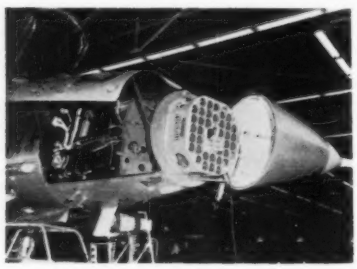
Before the flights could be attempted, much information was needed on the Voodoo's engine and afterburner performance at various altitudes. Preparations for cross-country speed hops called for extensive information on in-flight refueling problems and techniques. Photography provided an efficient and inexpensive answer to both needs.

To obtain this performance information, a duplicate panel containing approximately 40 instruments was mounted in the jet's nose. An Automax camera equipped with an 18½-mm lens made a continuous photographic record of all instrument readings. To save space, the camera was mounted within the instrument panel, shooting into a front surface mirror which reflected the readings. The camera was operated at two pulses per second during the jet's test runs, each frame covering the entire instrument panel. An intervalometer supplied timing pulses and a displacement-type magazine provided 200-foot film capacity.

To accomplish smooth in-flight refueling, repeated practice hookups were necessary. As the Voodoo rehearsed its technique with the Boeing *KC-135* jet tanker, Bell & Howell *70 KRM* 16-mm motion picture camera recorded the action. Final techniques were perfected through study of the film. The camera is a militarized version of the Bell & Howell *70* series camera. Used widely in military test work, the camera offers speeds of 8 to 64 fps and standard film capacity to 400 feet. Special modification by Traid Corporation will also enable it to accommodate a 1,200-foot external magazine.

The Automax camera operates at intervals up to 10 fps, and switches instantly to cine operation. Highly versatile, it is used in 90% of all airborne data-recording installations throughout the country.

All photographic equipment for the tests was supplied by Traid Corporation. The company designs, develops, and manufactures instrumentation cameras and accessories, and also distributes the products of other leading photographic manufacturers.



AUTOMAX camera, shown in the center of instrument panel, provided a continuous record of Voodoo in-flight performance by shooting into a front-surface mirror. Entire panel was mounted in the nose of the F-101 jet aircraft.

Summer Conferences, Seminars and Institutes

Pennsylvania State University. The Extension Conference Center of Pennsylvania State University, University Park, Pa., will offer a seminar in R and D Management Development from July 6-12; an Electrical Precipitation Seminar from June 9-13; and a Seminar on Theory and Design of Turbomachinery from June 15-27.

Columbia University. The Department of Industrial and Management Engineering will present its 9th Annual Industrial Research Conference, an intensive program in the analysis of practical problems of industrial research management, from June 1-6. Inquiries may be addressed to R. T. Livingston, director, Industrial Research Conference, 409 Engineering Bldg., Columbia University, New York 27, N. Y.

Human Engineering Institute. From June 10-13, the 6th Annual Human Engineering Institute will be presented at Stamford, Conn. by Dunlap & Associates, Inc. Under the direction of Dr. R. C. Casperson, the Institute will deal with human capabilities and limitations as they relate to the design of complex man–machine systems, specific equipment items, consumer products, and workplaces. Requests for further information should be addressed to Dr. Casperson, 6th Annual Human Engineering Institute, Dunlap & Associates, Inc., 429 Atlantic St., Stamford, Conn.

University of California. The first international symposium on Statistical Methods in Radio Wave Propagation, sponsored by the University Engineering Extension, will be held June 18-20. Participants from England, France, India, and the United States will present papers on topics including spectral analysis and estimation, median fields and median regression, and statistical treatment of ionospheric drifts. Further information may be obtained from Dr. W. C. Hoffman, Engineering Bldg., Room 3116, University of California, Los Angeles 24, Calif.

RWMA Sponsors Paper Competition

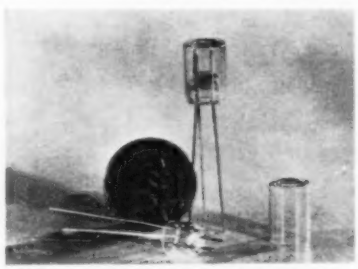
A contest for papers in the two categories of special projection welding and general resistance welding is being sponsored by the Resistance Welder Manufacturers' Association (RWMA). Papers dealing with the latest developments in projection welding; with all other types of resistance welding; and with educational and informative categories of welding production, machinery design and mechanization for welding are acceptable. A first prize of $600, second of $300, and third of $100 will be offered in both of the two classifications.

An application containing an abstract of 150 to 200 words, sufficient to characterize the paper, should be mailed by July 1, 1958. Authors should indicate whether the material has been previously published or orally presented. Manuscripts must be received by September 15, 1958. The minimum requirement is 2,500 words. The contest is open to anyone from the United States, its possessions, and Canada. The decision of the judges will be final.

Requests for applications and statement of rules should be sent to the Resistance Welder Manufacturers' Association, 1900 Arch St., Philadelphia 3, Pa.

High Strength in Crystalline Material

A new crystalline material, recently tested for use as a guided missile nose cone, is currently undergoing tests as a bearing part material for turbine engines.



ALL-GLASS transistor enclosure made by Corning Glass Works. Base and envelope of 200-mil lead circle enclosure are strong thin-walled precision glass tubing. New process hermetically seals parts at 1,000 C while semiconductor temperature is kept below 150 C.

Commercial production of tubing and plate, to be sold under the Pyroceram trade mark, was begun at the Corning Glass Works, Corning, N. Y.

The hardness of the material, combined with its ability to operate at high temperatures without deforming or softening, and a mechanical strength equal to cast iron, gives Pyroceram *9608* excellent characteristics for bearing parts. Other commercial applications of these new materials now being investigated include tubing for high-temperature heat exchangers, low expansion piston heads, precision-made aircraft structural parts and architectural curtain walls.

Pyroceram is an opaque ceramic that begins as a glass. Nucleating agents in the glass form centers of crystal growth on subsequent heat treatments, turning the material into a hard, white ceramic. A thin-walled tube of Pyroceram *9608*, developed for use in high temperature heat exchangers, can be heated to 1,300 F and then plunged into ice water with no effect.

Corning also announced the manufacture of an all-glass transistor enclosure. Production of the 2-piece transistor case was made possible by the development of a close-control electric sealing process. The base and envelope are hermetically sealed at 1,000 C while temperature near the semiconductor, less than $\frac{1}{4}$ inch away, is kept below 150 C. Sealing is done in approximately 10 seconds.

The new enclosure represents a major advance in glass encapsulation for electronic devices. Both base and envelope of the 200-mil lead circle enclosure are made of strong, thin-walled, precision glass tubing of high purity.

Current production of the new transistor case is limited to the 200-mil lead circle type for low-power units.

Additional Atomic Energy Conference Papers Titles

A total of 1,925 titles of scientific papers have been submitted for presentation at the 2nd International Conference on the Peaceful Uses of Atomic Energy. A list of 375 titles submitted by the governments was released by the United Nations, sponsors of the meeting to be held in Geneva, Switzerland, on September 1-13, 1958. Seven governments not represented previously have submitted titles in this new list. These listings are available from the United Nations, Department of Public Information, Press and Publications Division, United Nations, N. Y. Orders should be requested with the following numbers: Doc. A/CONF.15/DOCS/3 and Doc. A/CONF.15/DOCS/1/Add. 1.

Approximately 900 abstracts of scientific and technical papers have been forwarded to the United Nations and proposed for presentation by the United States at the Conference. This number was chosen by a reviewing committee out of 1,478 submitted to the AEC.

As at the first U.N. Conference on Peaceful Uses of Atomic Energy, held in Geneva in August 1955, a technical exhibits program and a technical film program will supplement the presentation of scientific papers.

The industrial design firm of Walter Dorwin Teague Associates, New York, N.Y., has been chosen by the AEC to plan, design, and co-ordinate the United States technical exhibit.

The success of the first program to stimulate international interest in peacetime uses of the atom resulted in United Nations action calling for the second meeting and even more countries are expected to take an active part in this year's conference.

The president of the 1958 Conference will be Prof. W. Perrin of the Commissariat à l'Énergie Atomique de France and the secretary-general will be Dr. S. Eklund of Sweden.

The U.S. AEC, as in 1955, is in charge of planning, preparing, and presenting the United States technical program.

E. S. Gardner is executive director of the AEC Office for International Conference, which was established to carry out plans for United States participation. Dr. L. D. P. King of the Los Alamos, N. Mex., Scientific Laboratory, is technical director.

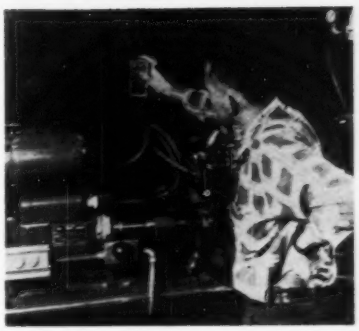
The scientific program will be presented in the Palais des Nations in Geneva. The Technical Exhibit will be presented in an exhibit hall to be built by the United Nations.

Control System Provides for Lower Costs

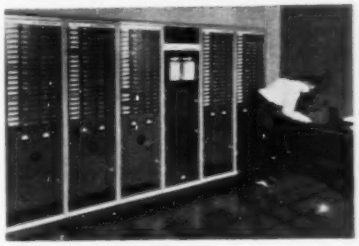
Lower manufacturing costs and greater productive efficiency result from a new system announced recently by Control Systems Company, Division of Hancock Industries, Inc., Jackson, Mich. The new system displays instantly in a central dispatch room what is happening at every machine in the production shop. A long-needed tool for manufacturing industries, the new equipment links every piece of productive machinery by means of electric wires to a central production monitor room. In the monitor room, up-to-the-minute production data is provided in visual form for production control personnel. The system eliminates the need for time-consuming paperwork at all production supervisory levels.

Wherever parts are mass-produced, the new electromechanical system, named Hancock Telecontrol, can monitor and control the entire production process, stage by stage, throughout each shift. It tells management at a glance how much is being produced, where, and what it costs. At the same time, in easily visible form, supervisors may tell what emergencies occur in the plant and require immediate attention, while the system routinely records incoming production data on registers for later use.

Within a Telecontrol installation, supervisors work in a central dispatch room, linked electrically to every piece of production equipment in the shop. This main "nerve center" includes one monitor cabinet and as many control cabinets as are needed—every group of 20 production machines requires one control package. In Hancock Manufacturing Company's Jackson plant, where first system is in operation, 200 machines connect to dispatch room, necessitating 10 control units.



MACHINE OPERATOR in need of more parts continues production but notifies the dispatcher of his needs by pushing alarm switch on the control box that is wired to the central dispatch room.



DISPATCHER pages a foreman in the plant, directing him to one of the machines requiring assistance. Flanked by control cabinets, the monitor unit has a 40-station key recorder for critical operations.

FOREMAN arrives within seconds at the machine after being summoned by the dispatcher over the public address system. When he has analyzed the trouble, he confers with the dispatch room regarding action.

Each machine or subassembly line has a control box that provides the machine operator a way of signaling the dispatch room. This box has two lights, a switch, a reset button, a lock, and a telephone jack. Both lights are duplicated on each of the control cabinet's 20 display panels. In normal production, only a green light is on, but when an operator needs help from his foreman, he signals by pushing an "alarm" switch, and a red light starts to flash in the dispatch room. At the same time, an audible "beep" warns the dispatcher to direct the foreman by public address system to the machine requiring assistance.

Once the foreman arrives, he can diagnose the trouble. If the operator requires more parts or materials for his machine or finished work taken away, the foreman

will plug a special telephone handset, which he always carries, into the control box and ask the dispatcher to send the stock man.

Should the trouble be mechanical and require repair, the foreman requests the dispatcher by his telephone for a maintenance man to be sent. He arrives quickly, having been summoned by the public address system. The foreman may then transfer the operator from a productive rate to downtime status by inserting a key he carries into the control box. This key, which only the foreman carries, turns the red light on continuously both at the box at the machine end and in the dispatch room display.

If the repair is a time-consuming one, the foreman will assign the operator to another machine already set up for production. In the past year, the system has reduced downtime at the Hancock plant by over 50%.

At the end of each shift, dispatchers transfer all production statistics to a five-channel tape add-punch machine so that other departments, such as accounting, planning, purchasing, production, and engineering may instantly compute their requirements and the day's production data.

The inherent simplicity of the Telecontrol's electromechanical design permits almost any plant maintenance crew to make repairs. In monitoring production through one centralized source, Hancock plant management reports that the system has provided them with a lower cost manufacturing operation and enabled the company to operate more profitably in making of auto parts.

Federal Space Exploration Commission

Creation of a Federal Space Exploration Commission with full power and resources to undertake long-range space programs has been urged by the National Society of Professional Engineers (NSPE).

In a policy statement approved by the group's Board of Directors at its Spring meeting in Lansing, Mich., the NSPE proposed that ". . . the Administration present to the Congress a program for the national direction of space exploration encompassing as full and comprehensive a legislative structure as that embodied in the Atomic Energy Act."

"It is of the utmost importance," the statement continued, "that the leadership of the Federal Government in the exploration of space not be confined to patchwork or piecemeal attempts merely to co-ordinate the research and development now being carried on by independent military and other groups."

The Board of Directors pointed out that "the crucial need of the hour is for the sort of dynamic leadership that will bring about full-scale participation in the responsibilities and benefits of the exploration of space by American industry, by the entire scientific, engineering, military, and educational communities, and by as broad a segment of the general public as possible."

Warning of the "ominous import of the implications in recent Soviet achievements which suggest that the USSR may be widening the gap in heavy rocket engines and specific plans for lunar and planetary exploration," the NSPE statement emphasized that United States space programs must be backed by "the full organization and resources of the United States of America."

The NSPE Board of Directors pointed out that this country "has as great a reservoir of scientific and engineering knowledge and skill as can be found in any nation on earth, but it is clear that America has not accorded the highest priority to the development of projects specifically directed to the furtherance of space rocketry and space exploration."

The NSPE statement proposed that the Federal Space Exploration Commissioners be appointed by the President, and that space projects be given legal and organizational status at the highest level of national policy.

After adoption by the NSPE Board, the statement was sent to President Eisenhower by G. H. Dyer, president of the 43,000-member engineering organization.

The National Society listed nine points as the basis for its proposals on outer space programs:

1. As a National enterprise, the exploration of space must be in the hands of civil authority. The intimate relationship of military considerations with progress in space technology, however, demands the closest sort of co-operation of the military with projects involving rocketry, satellites, and the like. A single Federal Commission acting under the authority of Federal statutes regarding space programs, would be able to give the military services adequate opportunity for rocket and missile development—as consistent with the defining of service roles at the highest policy level.

2. Greatly improved utilization of existing engineering and scientific manpower is today one of our most urgent needs. Under a Federal Space Exploration Commission, clear lines of authority could be established for utilizing professional engineering and scientific services to the best advantage in large-scale programs in all the specialized areas, and duplication of research and development could be avoided.

3. Private industry engaged in the immense rocketry, satellite, and other space projects should not be tied to the fluctuation of military budgets. Leadership by a Federal Commission for all space projects would have a stabilizing effect on the entire industry, and would serve to spread space project contracts as widely as possible throughout the industry.

4. One of the most frustrating problems concerning America's current activity in space projects arises in connection with the difficulty of pinning down responsibility for progress or lack of progress. A single Federal Commission would report to the President and to the Congress on all phases of the Nation's space activity.

5. A space exploration program directed by a Federal Commission could conduct educational and informational programs for industry, schools, and other groups as are now carried on by the Atomic Energy Commission. This would insure the widest possible dissemination of space knowledge and technology, consistent with National security.

6. The National economy will be strengthened by the incidental results of a major effort in space exploration, just as it has been strengthened by nuclear research and development.

7. Another area of interest that no doubt would fall to the Commission would be to explore totally the great import inherent in any space activity of weather control and forecasting.

8. Past and current American space projects suffer from a lack of long-range planning as to just what specific steps will be taken in the exploration of outer space, and according to what timetable. A Federal Commission could draw upon the thinking of a broad panel of top figures in science and engineering for the construction of realistic and specific projects and schedules for moving out into the solar system.

9. Only a truly National and fully mobilized assault on the exploration of outer space on the part of the United States can have the necessary psychological effect on our allies throughout the free world.

10. The realities of the international situation are such that two major powers are engaged in an intense competition for technological supremacy. The successful exploration of outer space is an inescapable part of that competition. The United States must put forth a full-scale Nationally organized space program in the interest of its citizens and the people of the free world.

Dramatic Lighting for Central Sphere of Atomium

Wall-to-wall fluorescent lighting, a dramatic system called "Sylva-Lume," was installed in the central sphere of the Atomium, "theme" building of the 1958 Brussels World's Fair.

Sylva-Lume, the latest in luminous ceilings, is an interchangeable plastic panel

FIRST MILITARY USE of Sylvatron image-producing panels is demonstrated by Dr. Keith Butler (*left*), manager of Sylvania Lighting Products. He compares operation of small model with 4-foot square simulation of training device's plotting screen as Harold Barkan (*center*), project engineer, Training Device Center, and Lieutenant (jg) T. R. Braby, USNR, assistant to the Commanding Officer and director of the Center, look on.

ATOMIUM, "theme" building of the 1958 Brussels World's Fair containing international displays of the peaceful uses of atomic energy, symbolizes the co-operative progress of mankind. Sylva-Lume permitted creation of a custom design from a few standard parts when installed in the central sphere of the Atomium. F. J. Rolando, manager of merchandising, Sylvania International, points to the central sphere of an Atomium model as he discusses the company's participation in the exposition with R. G. Slauer, sales manager—fixtures, Sylvania Lighting products.

system which permits the creation of a wide variety of custom designs of over-all patterns of color, form, texture, and style from a few standard parts.

The Sylva-Lume system "permits an architect, designer, or builder to custom-produce a ceiling lighting system that is unique in appearance, and marks the first time a designer has been able to use the artistic approach—as opposed to the engineering approach—to design such a system."

The Atomium, representing the arrangement of atoms in a crystal of iron, enlarged 160 billion times, rises to a height of 330 feet to tower over the other exhibition buildings and serve as the exposition's "trade mark." Containing international displays of the peaceful use of atomic energy, the Atomium symbolizes the co-operative progress of mankind.

Two major achievements in the development of "Sylvatron" image-producing panels were announced recently by Sylvania.

The successful achievement of electronic scanning through a version of Sylvatron was announced. "Scanning" is the process by which a moving spot of light is moved rapidly across a luminescent screen in repeated horizontal lines, one beneath the other, until the accumulated lines appear as a solid sheet of light or create a picture.

These panels utilize not only the principle of electroluminescence—the production of light by direct excitation of certain phosphors in an electric field—but also the principle of photoconductance, which is the influence of light on the flow of electricity through a solid.

The U.S. Navy will use Sylvatron panels for fleet maneuver training problems involving the movement of large fleets. Ship movements would be represented on the Sylvatron plotting screen by lighted tracks, triggered by a moving spot of light. This type reproduces optically the track of a mobile spot of light and can hold or "store" indefinitely the image thus created in visible form on the panel.

The second development employed a Sylvatron type in which the position of a spot of light on a screen can be controlled electronically. The company was able to achieve this scanning by means of electronic vertical and horizontal computer circuits into which were built a special circuit for suppressing annoying cross effects otherwise observed.

Research Reactor To Be Installed for Campus Training

Installation of the training, research, and isotope production reactor, called TRIGA, will take place in the Fall of 1958 on the campus of the University of Arizona (UA) at Tucson it was announced by the institution recently. The reactor was invented and developed by General Atomic Division, San Diego, Calif., of General Dynamics Corporation. It is said that the UA will be the world's first educational institution to have this multipurpose, inherently safe, 10-kw reactor.

The university's reactor will be placed in the north wing of its College of Engineering building. Partial financing for the UA project will come from a grant of $110,195 from the U. S. Atomic Energy Commission (AEC), which operates a program to assist qualified educational institutions to further their training and research activities in nuclear science and engineering.

Dr. T. L. Martin, Jr., head of UA's department of electrical engineering, said that TRIGA will be used as part of a broad program of research and teaching which will include such subjects as reactor engineering, the study of isotope production and application, and instrumentation through the use of isotopes.

Other areas of interest to the UA—chemistry, physics, bacteriology, zoology, botany, various kinds of agriculture, metallurgy, and mechanical engineering—also will find the reactor eminently suitable for research, Dr. Martin said.

One of the most significant features of TRIGA, it has been said, is its inherent safety. The fuel-moderator elements of the reactor are composed of solid homogeneous uranium-zirconium hydride, which was conceived and developed by General Atomic. Certain physical phenomena that are properties of this new nuclear fuel moderator make TRIGA a self-controlling, inherently safe reactor.

The TRIGA reactor core is at the bottom of a 20-foot pit. Above the core are 16 feet of water which not only acts as a shield, but also makes it possible for students working with the reactor to watch external moving parts and various experiments around the outside of the core. Earth surrounding the pit provides the remainder of the shielding.

The 10-kw TRIGA has three main facilities in and around the core for training, research, and isotope production. These facilities are known as the Lazy Susan, the rabbit tube, and the glory hole.

The Lazy Susan is a rotary specimen rack made of an aluminum ring. From the ring 40 aluminum cups are suspended. A surface hand crank rotates the specimen rack so that specimen containers may be loaded and unloaded. The two aluminum tubes descending to the raised ring circling the reactor grid plate are for turning and loading and unloading this 40-position specimen irradiation rack.

The pneumatic rabbit tube is used to extract rapidly radioisotopes that have extremely short half lives. Two concentric tubes lead down through the water and into the edge of the reactor core. The specimen is fed in by gravity through the inner tube and is ejected by filling the outer tube with pressurized carbon dioxide.

The glory hole, useful for reactor training, nuclear research, and isotope production, is a 1½ inch diameter tube which extends down through the center of the reactor core. This reactor produces useful quantities of radioisotopes of 62 of the first 83 elements.

Notes on Arctic IGY Research Team

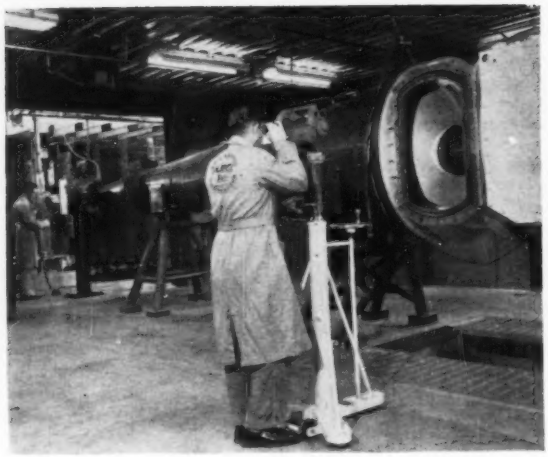
The month of March 1958 found a team of International Geophysical Year (IGY) scientists of Columbia University's Lamont Geological Observatory marking the completion of a full year of continuous manning of the northernmost United States station.

Although, at the moment, they are a few hundred miles from the actual North Pole, they expect to be able to reach it before the scheduled end of their vigil in December 1958, without stirring from their present camp. Station A, since its establishment some 700 miles from the pole in March 1957, has been led in shifts of several months each by staff members of Lamont Observatory acting as "station scientific leader" intermittently.

After moving with the ice cap to within 300 miles of the pole, the station began to drift south as the winter set in. The camp found itself to be some 440 miles away from it in the month of January 1958. However, it is hoped that the northward drift will resume in the spring and that the station will eventually cross the top of the world.

In their slow voyaging over the Arctic Ocean, the scientists have gathered a great mass of valuable information on seismology, oceanography, gravity measurement, geomagnetism, and auroral studies, although temperatures have gone below —50 F. Ironically, in the auroral studies, they have been handicapped by being too far north. The Northern Lights have been far more brilliant in Fairbanks, Alaska.

Many of their most important records and specimens have been obtained through a hole in the ice maintained without interruption. Among these have been the first photographs ever made of the floor of the Arctic Ocean and a number of cores or cylindrical samples of the floor sediments up to 7 feet long. These should yield significant clues to knowledge



ELECTRIC ARC to drive Tunnel Hotshot II is produced by charge stored in inductive coil at left in picture. Technician sights a high-speed camera on missile nose in test section.

U.S. Air Force photograph

of Arctic marine life, geologic history, and past climate. Moreover, with continuous depth soundings, they discovered in August 1958 what is apparently a submarine mountain range rising 5,000 feet above the 10,000-foot depth of the ocean floor.

The station, far from being completely isolated, has been visited once or twice a month by planes, and is in regular radio contact with the outside world. In fact, in the second such feat ever reported, one of the members of the team at the station in the Arctic, contacted on an amateur radio band another IGY Lamont Observatory scientist located 11,200 miles away in the Antarctic.

Escape Velocity Exceeded in Wind Tunnel

Escape velocity, the speed required to propel an aircraft or missile out of the earth's gravitational field into space, has been exceeded in a wind tunnel at the U.S. Air Force's Arnold Engineering Development Center, Tullahoma, Tenn. The test run peak lasted about $\frac{1}{10}$ second, during which an airflow of approximately nine miles per second was achieved. Special rapid-response instruments recorded the extreme flight conditions. Marking the first time that escape velocity, which is seven miles per second, has been reached in a wind tunnel, it was attained during calibration and shakedown runs in tunnel Hotshot II, part of the gas dynamics facility of the USAF's Air Research and Development Command. Details of the tunnel, designed, constructed, and instrumented by the Center's operating contractor, ARO, Inc., were announced recently.

Temperatures exceeding 40,000 F are caused by the friction of the air passing over the model, and the electrical discharge that heats the air creates pressures up to more than 30,000 pounds per square inch. Longer runs, under these conditions, are impossible because the extreme temperatures and pressures would cause the tunnel components to melt or even vaporize.

In the arc-driven tunnel, the airflow is heated and pressurized by an electric discharge generated by energy from a unique unipolar generator developed by Allis-Chalmers Manufacturing Company, Milwaukee, Wis., and stored momentarily in a huge inductance coil produced by Westinghouse Electric Corporation, Pittsburgh, Pa. When the tunnel is fired, the arc heats the air in the arc chamber. At predetermined temperature and pressure levels, the seal vaporizes. The air then flows from the arc chamber into and through the test chamber past the test object and on into the vacuum chamber.

Tunnel Hotshot II has a 50-inch-diameter test section, large enough to accommodate large-scale models of missile nose cones. It is a larger and improved version of Hotshot I, which has a 16-inch-diameter test section and which has been engaged in a series of test programs for a year. As test operations are begun in Hotshot II, operation of Hotshot I will be devoted to further investigations preliminary to the development of an even larger arc-driven tunnel, Tunnel F, now in the final stages of design.

Punch-Card Operators Taught Keyboard Automatically

The first completely electronic instructor—the Solartron Automatic Keyboard Instructor (SAKI)—which was shown for the first time at the Physical Society's Exhibition in London, England, in March, is the world's first thinking electronic teacher. SAKI is one of the practical offshoots of EUCRATES, the electronic brain employing cybernetic principles, first demonstrated at the 1956 Physical Society's Exhibition.

Designed for the training of operators of card punch machines, SAKI is much more than a training device. It is a teacher in the fullest sense of the word. Step by step, it takes the pupil along from the very beginning to the final, polished performance with complete, full-time personal tuition.

The rate of tuition adjusts itself to the pupil's ability to absorb and execute. The personal attention of SAKI is far more complete than would be possible with the finest human system. The idiosyncracies, the weaknesses, strengths, and errors are carefully noted and the pupil's exercises and tests adapted accordingly. The final result is an operator with a completely balanced skill and accuracy of operation. This is extremely important, because much of the time lost through inaccurate card-punching is caused by the fact that the personal operating weaknesses have not, with the human tutor, been overcome. Also, the preferential actions of certain fingers with particular keys causes a slightly uneven speed of operation. This unevenness is small enough to be unnoticed by the operator and human tutor. However, SAKI detects it with ease and thereby corrects it by modifying exercises accordingly.

Because SAKI plays a "game" with the pupil, the psychological reaction is extremely favorable. The pupil does not get bored or have a tendency to be bored because attention and concentration are caught and kept.

In the first stage, a card with figures is placed over the large group of instructing lights. The pupil is then asked by lights appearing behind numbers in succession to press the requisite punch key. In the beginning, to familiarize the pupil with the punch keys, SAKI gives the answer by lighting the correct light in the "punch" lights. But as the pupil quickly gains knowledge of the keys, the lights do not appear until after a few seconds delay or if the wrong key is pressed. This extinction occurs first with single lights then with groups of lights. When initial proficiency is obtained they do not light at all.

The next stage is working on the figures in the first of the four lines until a certain stage of skill is obtained. The same is done with the next line and so forth. Then the lights dodge about from line to line. The speed at which the figures appear is dictated by the speed of the pupil. They appear in faster succession until the limit of the pupil's skill is reached. Then the machine slows down and helps the pupil along. Thus, the machine continues to instruct and correct where the pupil finds difficulty until, finally, the pupil can operate all the keys and groups of keys with equal facility and speed and completely correctly.

Chemical Engineers Celebrate Jubilee Year

A delegation of chemical engineers from all over the world will be among those attending the Golden Jubilee Celebration of the American Institute of Chemical Engineers (AIChE), which will take place June 22-27 at Philadelphia, Pa. Leading scientists and engineers from education, industry, and Government will present more than 80 papers, summarizing 50 Years of Chemical Engineering Progress and discussing future applications and developments.

Among the events planned for the celebration are the Keynote, Special Awards, and Ceremonial Sessions, and the Golden Jubilee Banquet, at which C. H. Greenewalt, president of Du Pont will speak.

The three remaining founding members of AIChE will be presented with scrolls and awards by G. E. Holbrook, present AIChE president.

Earlier in the year, a bronze plaque was unveiled in the Engineers' Club, the same building in which the AIChE was founded in 1908.

Headquarters for the June celebration will be the Bellevue-Stratford Hotel. Further details are available from J. I. Savoca, Socony Mobil Oil Company, Inc., Paulsboro, N. J.

Improved Safe Highway Travel

Two ideas for improving safe highway travel—a road design plan and an experimental automotive control system—were included in a General Motors (GM) presentation to the Governors Conference Special Committee on Highway Safety meeting, held April 10-12, 1958.

State chief executives and their aides witnessed Proving Ground vehicle safety demonstrations dramatizing structural and functional dependability of today's automobiles in emergency situations.

Saturday at Technical Center GM research staff displayed its experimental unicontrol automobile which literally is driven by hand. It has a combined hand-operated electrohydraulic steering, braking, and throttle system—a further refinement of an automatically guided car the GM research staff introduced in February.

Only conventional item of the new car's control system is an automatic transmission lever on the stub of a wheel-less steering column. A four-inch "stick" topped by a heavy ball at the driver's right performs all other driving chores—steering, braking, and accelerator control.

Off-the-road accidents on GM Proving Grounds were comparable to those occurring beside public highways, and surveys were made of the GM road network to determine how they could be prevented.

Trees, posts, and other roadside obstacles were systematically cleared from the pavement shoulders. As a result of the clearing and shoulder regrading program, several potential crashes by test drivers have been averted.

The program also includes automotive crash tests against guard rails, inasmuch as some unremovable roadside obstacles must be protected by such structures. Properly designed and anchored rails have proved feasible in reducing severity of off-the-road mishaps.

It will be impossible, except in event of complete automatic control of highway vehicles, to prevent some cars from leaving the roads when drivers fall asleep, swerve to miss traffic crises, or skid off the pavement because of slippery conditions.

The unicontrol car, which the governors saw at Technical Center, is an experimental effort to improve the driver-automobile relationship.

Unicontrol eliminates the traditional mechanical linkage between steering gear and front wheels. The driver simply handles the knobbed four-inch stick beside him. The car turns right as he moves the stick in that direction; left when he moves it left.

Steering ratio varies with car speed. In effect, this means that a quick, abrupt motion of the control will not throw the car into a skid, such as would occur if a driver were suddenly to twist his steering wheel at high speed in a conventional car.

The stick may be moved in any direction about its pivot, with a two-inch travel in any direction from center. It is spring-centered and the driver exerts only one pound of pressure to move it. Also, it is damped to prevent it from oscillating or wobbling when released.

To accelerate the car the driver merely pushes the stick forward, and to apply brakes he pulls it backward.

Wires are the only connection between the control stick and the steering, throttle and brakes. An electronic computer and hydraulic power supply, similar to the one in the automatically guided car GM demonstrated comprises the rest of the system.

In fact, the unicontrol may also be operated on the 2½ mile check road at Technical Center with its "magnetic path" from an electrical cable sealed in the pavement. The unicontrol car would follow the electrical path and steer automatically just as the earlier version of the automatically guided car did.

The system is said to have a number of interesting features:

1. Car motion "feedback" to the driver. For instance, if the car skids, the inertia of the heavy knob at the end of the stick provides a correct indication of the way to correct the car's course. The driver can feel a force on the stick that "tells" him to correct his direction and pull the vehicle out of a skid or swerve.

2. It has what engineers call "pendulum stability." Among other things, this stabilizes a vehicle whenever it is buffeted by side winds or other external disturbances, such as road bumps or shocks, and keeps it on a straight path.

3. Only small motions are necessary to control car. Thus, in parking or low speed driving, short movements of the stick are sufficient to maneuver a vehicle, and at high speeds these same movements can be made without throwing the car into a skid.

Atomic Clock for Space Travelers' Use

An "atomic clock" that could be used to guide space travelers was described at the national convention of the Institute of Radio Engineers in New York recently. The clock is being developed by engineers of International Telephone & Telegraph Corporation (IT&T) at their laboratories in New Jersey.

The gas-cell device, which uses optical pumping and optical detection, was described by Maurice Arditi, a senior project engineer at the corporation's Federal Telecommunication Laboratories (FTL), Nutley, N. J., and Dr. T. R. Carver, of Palmer Physical Laboratory, Princeton University, who served as a consultant on this development.

Experiments using sodium and cesium atoms are being conducted at the Nutley laboratories under Mr. Arditi's direction. Tests indicate that the clock is so accurate it would vary only one second in 100 years. This error factor is expected to be narrowed down as the work on the project is continued.

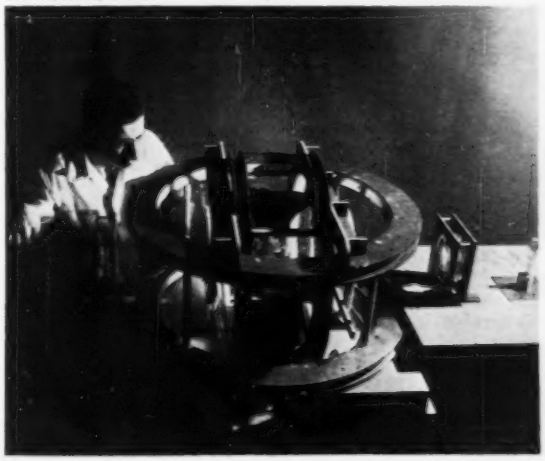
The clock is not a wall or mantel fixture, although it could be adapted for that purpose. It is a small, lightweight, portable measuring device. Operated by electric power, it is relatively unaffected by external conditions, can take rough usage, and is ideally suited for aircraft and ships. It will have civilian and military adaptations as soon as all of the present experimentation is completed.

FTL engineers pointed out that the clock will be an invaluable aid to astronomers and visualize it as necessary equipment on any rocket ship that might be used to travel the universe from planet to planet.

Atoms in vapor form in a chamber are acted on by light and radio energy in the clock. The light comes from a vapor lamp using the same atoms as those in the chamber. A regular, measurable resonance is established roughly similar to the pendulum motion of a mechanical or electric clock.

Details of the way the clock works are contained in the paper titled: "A Gas Cell 'Atomic Clock' Using Optical Pumping and Optical Detection."

Courtesy Handy-Boesser



ATOMIC GAS CELL, surrounded by magnetic shielding, was used by engineers of IT&T in experiments at FTL research division leading toward development of a light weight, portable "atomic clock" to provide a highly accurate time standard for ships, supersonic planes, astronomy, missiles and, in the future, space travel by rocket.

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Reactor Developments and Nuclear Technology Briefs

Niobium Technology. Prospects for greatly expanded use of niobium in nuclear technology has caused the Battelle Memorial Institute to evaluate its applications. The advantages and disadvantages are reviewed extensively for use in nuclear reactor fuel elements.

The advantages of niobium have been found to be its low neutron absorption, its strength at high temperatures, its good behavior when alloyed with uranium, its corrosion resistance under nonoxidizing conditions, and its relatively easy high-purity fabrication.

Niobium's disadvantages are found in its high cost of production, low oxidation resistance, and the need (at present) to clad the niobium with an oxidation-resistant alloy.

It is felt that increased use of niobium as an alloying material in uranium will depend upon whether a metallic fuel alloy, or a compound such as UO_2, proves to be the best kind of reactor fuel in the long run.

Plutonium. The potential value of the element as a nuclear reactor fuel has been realized for almost two decades. However, it is an alpha emitter, like uranium, which also gives off gamma radiation. Its extremely high ionizing potential, on the other hand, makes the alpha particle dangerous once it reaches the vital organs of the body (in the case of plutonium, the bones). Hence, personnel must be protected by the use of special equipment.

Fabrication of plutonium involves the familiar techniques employed for the more common metals. Plutonium and its alloys can be melted, cast, and fabricated by conventional methods, but because of the allotropic transformations, complex crystal structures, volume changes, etc., unalloyed plutonium does not respond well to many mechanical forming techniques.

EBWR Power Level Tripled. The Experimental Boiling Water Reactor at the Argonne National Laboratory, of the AEC, Lemont, Ill., was successfully operating at a 62,000-kw heat power level in recent experiments—more than triple the original design operating level of 20,000 kw. The first nuclear reactor built by the AEC, the EBWR has one specific purpose—experimental generation of electricity.

High-Flux Research Reactor. A new research reactor went critical recently at Oak Ridge National Laboratory, which is a high-flux, tank-type unit immersed in a pool. For fundamental use in research and engineering studies, major design emphasis was placed on flexibility to permit many kinds of experiments close to the reactor core. A heterogeneous reactor, the Oak Ridge Research Reactor is moderated and cooled with demineralized water.

Brussels Fair AEC Display. An *AGN-211* reactor, manufactured by the Aerojet General Nucleonics of San Ramon, Calif., will be installed in the International Science Section of the 1958 Brussels World's Fair. The first portable pool-type reactor was activated with 780 grams of contained U-235, the lowest critical mass in a pool-type reactor. It is estimated that some 30 million persons will attend the Fair.

New Zealand Atoms-for-Peace Mission. A five-man mission of the AEC is holding a series of Atoms-for-Peace discussions with New Zealand scientists, educators, and government officials on various aspects of peaceful applications of nuclear energy. Medical, agricultural, and industrial uses of isotopes are on the agenda, as well as administration, development, and organization of a nuclear research institute, health and irradiation problems, and siting and operating a research reactor.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, *Electrical Engineering* reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Illustrations should be submitted in duplicate, one copy and inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Deduction Correct

To the Editor:

Reference is made to the paper "Entering the Machine Domain" by S. L. Seaton, in the April 1958 issue of *Electrical Engineering*.

On page 292, RANGE OF STIMULI, third paragraph, this paragraph should read as follows:

> It has been observed by Cissin and Finan that a transition has taken place over the years in type font of type-(writer numerals such that—etc)

rather than:

> In the acoustical field, experiments have demonstrated that a number of objects struck a ringing blow un-(writer numerals such that—etc.)

Incidentally, this error is one of the best examples of what the article is talking about that I have ever seen. It is just slightly over a one per cent error counting both omission and substitution. I am afraid that the typesetter must have been reading as he worked and developed a Freudian block because of the context!

Sincerely yours,

S. L. SEATON

(Headquarters, U.S. Continental Army Command, Fort Monroe, Va.)

EDITOR'S NOTE: The author is correct: it was a printer's error. We apologize for him.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ADVANCED DYNAMICS. By J. E. Younger. Ronald Press Company, 15 E. 26th St., New York 10, N.Y., 1958. 285 pages, 6¼ by 9¼ inches, bound. $8.50. Covers the dynamics of beams, rectilinear motion, angular motion, plane motion, and motion in three dimensions. Concepts used include D'Alembert's principle, Lagrange's equation of motion, moving axes, relative motion, the free-body diagram, and the ellipsoid of inertia. Numerous problems are worked out in detail to illustrate the application of principles and methods, and, where possible, alternate methods of solution are presented.

ASTM STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS. Published by the American Society for Testing Materials (ASTM), 1916 Race St., Philadelphia 3, Pa., 1957. 1,103 pages, 6 by 9 inches, paper. $8. Contains 188 standards of which 43 are new, recently revised, or have had their status changed. Among the major areas covered are crude petroleum; natural gases; butadiene; motor and aviation fuels; petroleum lubricants; diesel fuels; and lubricating, industrial, and turbine oils.

AMERICAN POWER CONFERENCE PROCEEDINGS, VOLUME XIX, 1957. Published by the Illinois Institute of Technology, Technology Center, Chicago 16, Ill., 1957. 746 pages, 6¼ by 9¼ inches, bound. $8. Papers emphasizing broad aspects of technical development. A wide variety of topics are presented including steam and gas turbines, industrial power plants, condensers and feedwater circuits, extrahigh-voltage systems, electrical distribution, computers and network analyzers, nuclear energy, and water technology.

BASIC FEEDBACK CONTROL SYSTEM DESIGN. By C. J. Savant. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 418 pages, 6¼ by 9¼ inches, bound. $9.50. Servomechanism theory and design is presented from a fundamental viewpoint by means of practical examples. The approach utilized is based on a combination of the root-locus and frequency-analysis method, and although emphasis is on linear servomechanism design, nonlinear servomechanism analysis is included. Along with basic material, information is provided on components, gyroscopes, force-balance transducers, and inertial navigation.

CONTRACTS, SPECIFICATIONS, AND LAW FOR ENGINEERS. By C. W. Dunham and R. D. Young. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 550 pages, 6¼ by 9¼ inches, bound. $7.50. Included is an explanation of the basic principles of the law of contracts; a discussion of the application of these principles to construction contracts in particular, with data on the preparation of specifications; and a consideration of the various fields of law of special interest to the engineer. The authors attempt to state legal principles simply and clearly rather than quote extensively from involved court decisions or complicated legal documents.

ELECTRONIC SEMICONDUCTORS. By Eberhard Spenke. Translated from the second German edition by D. A. Jenny and others. McGraw-Hill Book Company, Inc., 330 W.

42nd St., New York 36, N.Y., 1958. 402 pages, 6¼ by 9¼ inches, bound. $11. An advanced study of semiconductor physics. The book begins with fundamental concepts, including a detailed description of the operation of crystal rectifiers and the physics of crystal amplifiers, and proceeds to such topics as quantum mechanics of the hydrogen molecule, the band model, Fermi statistics of electrons in a crystal, imperfection equilibriums, and boundary layers in semiconductors. The translators have added problems to each chapter and a new section on junction capacitance.

ELECTRON-TUBE CIRCUITS. By Samuel Seely. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., second edition, 1958. 695 pages, 6¼ by 9¼ inches, bound. $10.50. The present edition contains a considerable amount of new material including an analysis of R-C feedback amplifiers, FM discriminators, electronic computing circuits and devices, and the theory of clamping. In addition, the treatment of the principles of feedback has been expanded as has the material on solid-state electronics, the transistor, and the theory of transistor circuits. Approximately one half of the book deals with radio engineering; the rest is concerned with radar, television, electronic control and instrumentation, and computers.

ENGINEERING PROBLEMS MANUAL. By F. C. Dana and L. R. Hillyard. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., fifth edition, 1958. 309 pages, 6¼ by 9¼ inches, bound. $5.50. The author's main purpose is the development of a systematic approach to the analysis of practical engineering problems and the numerical calculations involved in their solutions through the utilization of the principles of physics and mechanics. This edition includes additional material on compound interest and a new chapter on the art of problem solving.

EXTERIOR BALLISTICS OF ROCKETS. By Leverett Davis, Jr. and others. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1958. 457 pages, 7¾ by 10¼ inches, bound. $8.50. Explains the basic theory of the exterior ballistics of rockets without moving control surfaces. Emphasis is placed on the physical understanding of rocket behavior as well as on the mathematical formulation of the theory. Equations of motion are formulated and solutions are worked out for many different cases. The first portion of the book is concerned with fin-stabilized rockets including the force system, the motion during and after burning, the launching process, and the ballistics of rockets fired forward from aircraft. The second portion deals with essentially the same aspects in relation to spin-stabilized rockets.

FEEDBACK CONTROL SYSTEMS. By O. J. M. Smith. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 694 pages, 6¼ by 9¼ inches, bound. $15.50. An advanced text that presents the relationship between the open loop transient, sinusoidal and statistical response and the closed loop transient, sinusoidal and statistical response. Given one of these responses, the others may be calculated with the methods described. The material contained is divided into four sections dealing with linear analysis, linear synthesis, steady-state nonlinear analysis, and nonlinear synthesis.

FUNDAMENTAL PRINCIPLES OF TRANSISTORS. By J. Evans. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1958. 255 pages, 5¾ by 9 inches, bound. $6.75. A concise explanation of the principles underlying the operation of transistors. A preliminary section describes the theory of semiconductors. This is followed by units on the measurement of semiconductor parameters, the theory of the p-n junction, junction and point-contact transistors, measurement of transistor parameters, manufacture of transistors, and silicon and other transistor materials.

HUMAN ENGINEERING. By E. J. McCormick. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1957. 467 pages, 6¼ by 9¼ inches, bound. $8. A study of the adaptation for human use of work equipment, work space and environment, and consumer products. Topics included are illumination, visual displays, color, atmospheric conditions, arrangement of equipment, and the design and arrangement of controls. In addition, several chapters deal with various aspects of the human organism and the way in which motor activities are carried out.

AN INTRODUCTION TO THE THEORY OF RANDOM SIGNALS AND NOISE. By W. B. Davenport, Jr., and W. L. Root. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 393 pages, 6¼ by 9¼ inches, bound. $10. A systematic treatment of communications engineering noise problems, utilizing a consistent set of methods derived from the theory of random processes. An introduction to probability theory and statistics and to the statistical properties of the Gaussian random process is given. This is followed by the theory of filters for minimizing the mean-square error or maximizing the signal-to-noise ratio, the transfer–transform method of analyzing signals and noise in nonlinear devices such as limiters and detectors, and applications of statistical methods to the design of a radio or radar receiver.

LOGICAL DESIGN OF DIGITAL COMPUTERS. By Montgomery Phister, Jr. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 408 pages, 6¼ by 9¼ inches, bound. $10.50. Describes methods and techniques for the design of general- or special-purpose computers by use of synchronous circuit components. The book discusses in detail the Veitch Diagram method of simplification of Boolean equations, the difference-equation approach to memory elements, the Huffman–Moore model of digital systems, and the complete solutions to flip-flop input equations. A mathematical introduction to Boolean algebra is included.

NATIONAL CONFERENCE ON TUBE TECHNIQUES. Proceedings of the Third Conference, 1956. Published by New York University Press, Washington Square, New York 3, N.Y., 1958. 128 pages, 8½ by 11 inches, paper. $5. A collection of papers devoted to manufacturing methods and structure of vacuum tubes. Topics discussed include new ceramics and bonding materials, cathode construction and materials, welding techniques, flint and particle control, high-voltage regulators, optimum vacuum tube bake-out time, measuring correction potential, and continuous getters. The conference was sponsored by the Advisory Group on Electron Tubes of the Office of the Assistant Secretary of Defense, Research, and Engineering of the United States.

NETWORK SYNTHESIS, VOLUME I. By D. F. Tuttle, Jr. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 117 pages, 6 by 9¼ inches, bound. $23.50. A thorough presentation of the principles of synthesis of electric networks in which steady-state behavior as a function of frequency is important. Aspects discussed are: network elements and their behavior, the complex frequency variable, properties of driving-point immittance functions, the nondissipative one-terminal pair, the R-C and R-L one-terminal pairs, and the R-L-C one-terminal pair. Extended treatments are given for the approximation problem and the potential analogy.

THE PHYSICAL CHEMISTRY OF ELECTROLYTIC SOLUTIONS. By H. S. Harned and B. B. Owen. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N.Y., third edition, 1958. 803 pages, 6¼ by 9¼ inches, bound. $20. Presents the experimental methods, theory, and properties of strong and weak electrolytes. New sections included in the revised edition are: Mayer's cluster theory, conductance theory with inhomogeneous terms and ion size parameters, and general theory of the Wien effect. In addition, expanded treatments are provided for the diffusion of electrolytes and self diffusion of ions, and for the thermodynamics of two electrolytes in water.

THE PREPARATION OF PROGRAMS FOR AN ELECTRONIC DIGITAL COMPUTER. By M. V. Wilkes and others. Edison-Wesley Press, Cambridge 42, Mass., second edition, 1957. 238 pages, 6¼ by 9¼ inches, bound. $7.50. The present edition has been enlarged to offer a general introduction to programming for any computer of the stored-program type. The first part of the book gives practical examples of programming and surveys various types of order codes to be found in digital computers. In addition, it discusses input and output, the contents of a library of subroutines, error diagnosis, and advanced methods. The second and third parts deal with the library of subroutines used with the electronic delay storage automatic computer.

THE PRINCIPLES OF QUANTUM MECHANICS. By P. A. M. Dirac. Oxford University Press, 114 Fifth Ave., New York 11, N.Y., fourth edition, 1958. 312 pages, 6¼ by 9½ inches, bound. $5.60. A standard work that has now been revised to present a new concept of quantum electrodynamics, taking into account the creation and annihilation of electron-position pairs. Aspects of the subject dealt with are quantum conditions, the equations of motion, the perturbation period, collision problems, systems containing several similar particles, the theory of radiation, the relativistic theory of the electron, and quantum electrodynamics.

SCIENTIFIC SOCIETIES IN THE UNITED STATES. By R. S. Bates. Columbia University Press, 2960 Broadway, New York 27, N.Y., second edition, 1958. 297 pages, 6 by 9¼ inches, bound. $6.50. An historical account of the development of scientific and technological societies in America from their beginnings in the 18th Century to the present. This edition includes a new chapter on the activities of societies since World War II. The extensive bibliography has been completely revised and contains further sources of information for most of the major and many of the smaller societies.

SOURCEBOOK ON ATOMIC ENERGY. By Samuel Glasstone. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., second edition, 1958. 641 pages, 6¼ by 9¼ inches, bound. $4.40. A revised edition of a widely accepted sourcebook on atomic and nuclear science. It relates the development of the theories explaining the phenomenon of radioactivity and provides a description of the construction and operation of cyclotrons, synchrotrons, and nuclear reactors. A new chapter has been added on nuclear reactors and new discoveries are presented such as the identification of hitherto unknown fundamental particles, the transmutation of new elements, and advances in the use of isotopes.

SYMPOSIUM ON INSULATING OILS. Published as Special Technical Publication No. 218 by the American Society for Testing Materials (ASTM), 1916 Race St., Philadelphia 3, Pa., 1957. 39 pages, 6¼ by 9¼ inches, paper. $1.75. The two papers presented are: (1) evaluation of laboratory tests as indicators of the service life of uninhibited electrical insulating oils, and (2) the use of solid and liquid catalysts for the accelerated aging testing of transformer oil. They are concerned with insulating oil for use in transformers and related electrical equipment, with particular reference to the need for adequate test methods to evaluate new oils, oils in service, and reclaimed oils.

THE THRESHOLD OF SPACE. Proceedings of the Conference on Chemical Aeronomy, 1956, edited by M. Zelikoff. Pergamon Press, 122 E. 55th St., New York 22, N.Y., 1957. 342 pages, 7¼ by 9¾ inches, bound. $15. Papers presented by specialists in upper atmosphere physics and chemistry as well as those engaged in the study of aerothermochemistry. The papers are classified under four headings: (1) atmospheric photochemistry, (2) spectroscopy and photochemistry, (3) rocket probing of the upper atmosphere, and (4) phenomena produced by hypersonic flight. A feature of the

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volume is the inclusion of discussions on shock tube and associated phenomena.

TRANSISTOR PHYSICS AND CIRCUITS. By R. L. Riddle and M. P. Ristenbatt. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1958. 428 pages, 6¼ by 9¼ inches, bound. $10. An introductory text divided into two sections, the first dealing with the physical background of transistors and the second with circuit theory. Topics discussed include small signal, power, and cascade amplifiers; bias stability and d-c amplifiers; feedback; noise; and transistor oscillators and multivibrators. The treatment of the subject is simplified by the use of hybrid *h* parameters for design equations.

TRANSISTOR RELIABILITY SYMPOSIUM PROCEEDINGS. Published by New York University Press, Washington Square, New York 3, N.Y., 1958. 128 pages, 8½ by 11 inches, paper. $5. Areas dealt with include transistor reliability and military requirements, reliability of power transistors, life experience with surface barrier transistors, radiation effects in semiconductor devices, effects of gamma radiation on transistor parameters, life study of low power transistors, and stabilizing techniques for wide temperature range amplifiers. The symposium, held in September 1956, was sponsored by the Advisory Group on Electron Tubes of the Office of the Assistant Secretary of Defense, Research, and Engineering of the United States.

TECHNICAL LITERATURE

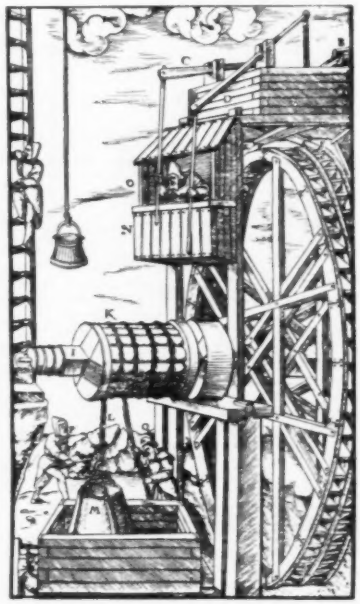
The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

DIGEST OF THE LITERATURE ON DIELECTRICS, VOLUME XX. Edited by J. D. Hoffman and John Hart of the National Academy of Sciences–National Research Council, this volume covers literature published during 1956. The material was gathered mainly from engineering and scientific journals, but also contains digests of books and references to Ph.D. theses and papers given at scientific meetings. The Digest is divided into three main parts: Part I is devoted to instrumentation and measurements, and contains tables of dipole moments, dielectric relaxation times, and dielectric constants; Part II deals with molecular and ionic interactions in dielectrics, conduction phenomena, dielectric breakdown, and ferroelectric, piezoelectric, and ferromagnetic materials; and Part III is concerned mainly with insulating materials as they are used in practical applications, dealing principally with rubber and plastic insulation, insulating liquids and films, and ceramic insulation. The Digest, Publication 562, is available at $5 from the Publications Office of the National Academy of Sciences–National Research Council, 2101 Constitution Ave., Washington, D. C.

PROCEEDINGS OF THE 4TH ANNUAL COMPUTER APPLICATIONS SYMPOSIUM. Sponsored by the Armour Research Foundation of Illinois Institute of Technology, the symposium stressed new areas of application, use of new computers and accessories, and recent developments in automatic programming. As in previous years, the dual structure of the conference emphasized business and management applications on the first day, and engineering and research applications on the second day. Copies of the Proceedings may be ordered from Armour Research Foundation of Illinois Institute of Technology, MF: CA4, 10 W. 35th St., Chicago 16, Ill. Price $3.

INDUSTRIAL NOISE MANUAL. Compiled by the Noise Committee of the American Industrial Hygiene Association (AIHA), the manual provides a comprehensive coverage of noise, its evaluation, and control. It is composed of 10 chapters, each dealing with some phase of industrial noise. Of particular interest is the chapter on noise control, which includes some 55 specific engineering installations showing before and after noise exposures. The manual discusses such subjects as the physics of sound, sound transmission, measurement of sound, instruments, techniques, procedures for making sound surveys, calibration of instruments, how we hear, effects of noise, why we do not hear, measurement of hearing, medical control and hearing conservation, engineering control of noise, and personal protective measures. The manual is available from AIHA, 14125 Prevost, Detroit 27, Mich., at $7.50, and contains 107 pages.

AGRICOLA ON METALS. By Bern Dibner, this is a distillation of the 16th Century treatise on mining and metallurgy, "De Re Metallica," written by Georgius Agricola. It first appeared in English in 1912 after five years of research and translation by Mr. and Mrs. Herbert H. Hoover. Agricola's aim was to write a textbook on mining and metallurgical engineering for his contemporaries of the 1500's. What emerged was an encyclopedic, richly illustrated record of a highly developed industrial culture that flourished a good 200 years ahead of the beginnings of the Industrial Revolution. Agricola, born in Saxony in 1494, served as town and city physician for



REVERSIBLE HOIST, 16th Century, driven by water wheel with two sets of blades. One of 70 early mining machinery illustrations included in Burndy Library's "Agricola on Metals."

mining communities where he found his professional training helpful in observing and recording the work of those early miners and metalworkers. The present edition is a crystallization of "De Re Metallica" for those interested primarily in its historical significance. Over 70 selected woodcuts from an original edition in the Burndy Library are contained in this 128-page work. It may be purchased from the Burndy Library, Norwalk, Conn. at $2.50.

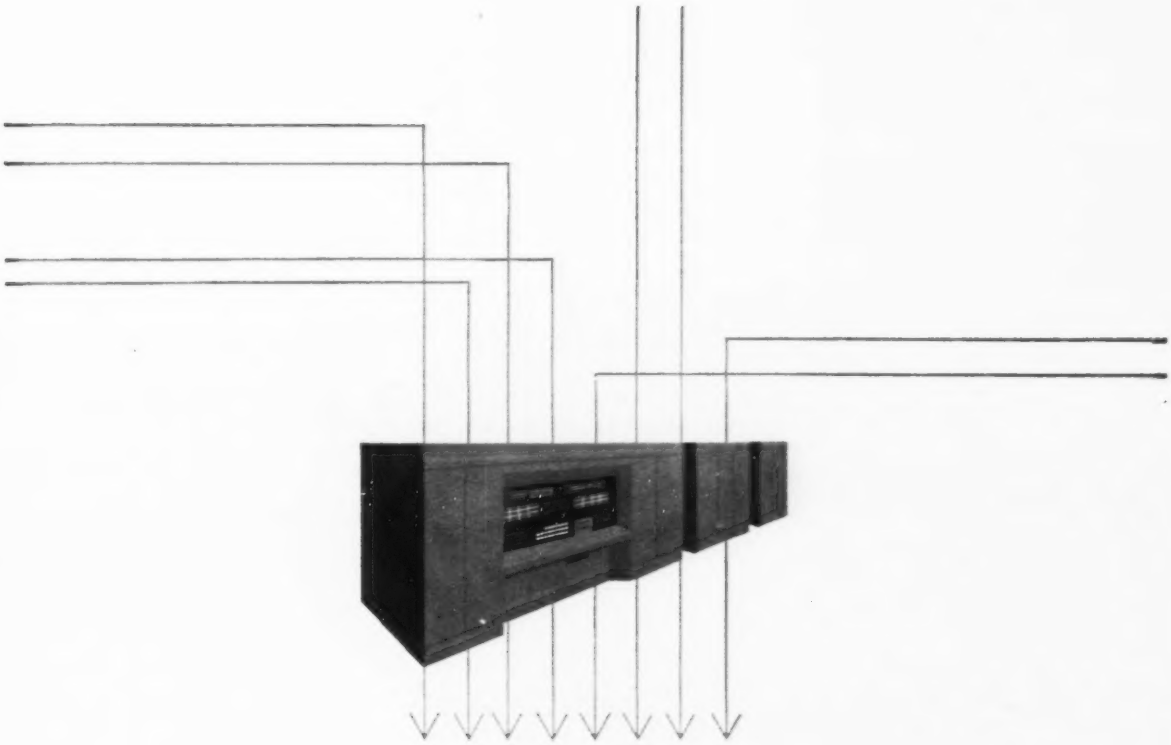
TECHNIQUES FOR APPLICATION OF ELECTRON TUBES IN MILITARY EQUIPMENT. This publication, *PB 111644R-2*, R. S. Whitlock, Wright Air Development Center, U. S. Air Force, is a revised edition of an Air Force guide to equipment designers in the application of electron tubes and has been released for industry use through the Office of Technical Services (OTS), U. S. Department of Commerce. The 558-page volume deals with electronic equipment design as it is influenced by electron tube procurement specifications. Application information on 52 tube types is presented in a format permitting quick reference by design engineers. In some cases, facts, data, and advice are given which are not available elsewhere in consolidated form. A section of the manual discusses properties common to all electron tubes, and another considers the effect of these properties in circuit design. A check list is included for use of the circuit designer to insure coverage of all important design factors. Mechanical, electrical, and environmental information on specific tube types is included, together with any application notes which are uniquely applicable to specific tube types. Observed property behavior on specific tube types is outlined. The publication supersedes WADC Technical Report 55-1 of the same title dated October 1955, and may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C., price $7.

RADIOISOTOPES. This symposium, Special Technical Publication No. 215 of the American Society for Testing Materials (ASTM), covers testing techniques utilizing radioisotopes and demonstrates the wide range of industrial applications to which they may be put. Changes in physical properties of materials as a result of radiation are discussed in some of the papers. Case histories are presented ranging from electroplating studies, the evaluation of rubber deterioration, and the mechanism of detergency, to the analysis of trace materials by neutron irradiation and the achievement of process control via tracers during full-scale petroleum refinery operations. Extensive references and many illustrations are included. Copies of this 100-page book may be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. at $2.75 each.

SOVIET BLOC INTERNATIONAL GEOPHYSICAL YEAR INFORMATION. These weekly reports contain information selected and translated from foreign-language publications regarding Soviet bloc plans and endeavors, in connection with the International Geophysical Year (IGY), in rockets and artificial earth satellites, upper atmosphere, meteorology, oceanography, latitude, seismology, glaciology, the Antarctic, and other subjects. Prepared primarily for the information of U. S. Government scientists, the reports are being published by the Office of Technical Services (OTS) for the benefit of non-Government scientists who may subscribe to the series for $10. The series, which runs from February 14, 1958 to January 2, 1959, may be ordered as *PB 131612* from OTS, U. S. Department of Commerce, Washington 25, D. C. Back issues to February 14 will be supplied to subscribers regardless of the date of their order.

ANNUAL REPORT 1957, NATIONAL BUREAU OF STANDARDS. This report reviews the work of the National Bureau of Standards for the past year, presenting some of the more significant achievements resulting from its efforts to establish new and better standards of physical measurement and develop techniques and instruments for using these standards throughout the country. Some of the fields covered in this report are electricity and electronics, atomic and radiation physics, organic and fibrous materials, data-processing systems, and building technology. The report may be ordered from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at 45¢.

PRINCIPLES AND PRACTICES OF TAPE AND DISC RECORDING. These notes on the 4th Audio Engineering Society (AES) lecture series have been published in two volumes. The objectives of the lecture series were to set forth the principles and practices of sound recording which have firm bases in physics and engineering, as well as those methods which have been empirically tested and found to be useful; to relate them to each other; and to delineate the problems which remain to be solved. Some of the subjects discussed during the 30-lecture series were: stereophonic and multichannel magnetic tape recording, noise suppression in audio systems, processing of matrices in disc recording, studio acoustical requirements, and philosophy of audio signal recording. Price for the two volumes is $7.50, with a reduced rate of $5 to members of AES. They may be ordered from Sumner Hall, Lecture Series Chairman, Amityville, L. I., N. Y.



The **ORGANIZATION** and **RETRIEVAL** of **INFORMATION**

The organization and retrieval of large volumes of diverse types of information is rapidly becoming one of today's more serious problems. Major areas where the problem exists include business and industry, the military, the government, and the scientific and engineering community itself.

In its simpler forms, the problem may involve, for example, the automatic handling and analysis of business data such as payrolls, sales and manufacturing figures, insurance premiums, and other essentially statistical data. At the other extreme are certain complex military situations which require the concurrent interpretation, analysis, and integration on a very short time scale of data from a wide variety of sources, including field reports, photographs, news reports, estimates of industrial activity, and the like. In many of these situations, there is the additional requirement to translate the information from a foreign language into English.

The development in recent years of electronic data handling equipment is now making possible the practical solution of many of these problems. Such equipment has the capability to perform arithmetic operations, make decisions among alternatives, store and retrieve large quantities of information, and at high speed automatically perform long, complex sequences of operations.

At Ramo-Wooldridge, work is in progress on advanced information handling systems that are characterized by large volume and widely different forms of information, short time scales, and a variety of uses and users. The scope of the work includes the planning of systems and procedures, programming various types of data handling equipment, and formulation of requirements for new equipment. Research is also under way on the machine translation of foreign languages into English.

Engineers and scientists with experience in the following fields are invited to explore the wide range of openings now available:

Systems Engineering
EDP Systems
Computer Programming
Console Design
Display Development
High Acuity Optics
Photo Interpretation

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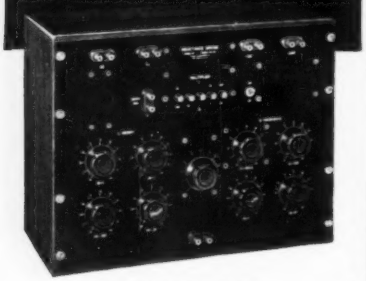

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Accurate inductance measurement with or without superimposed D.C., for all types of iron core components.

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- ACCURACY — 1% to 1000 Cycle, 2% to 10KC
- CONDUCTANCE — 1 Micromho to 1 MHO
- "Q" — 0.5 to 100
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VARIABLE TEST VOLTAGE MEGOHMMETER NO. 1620

The Freed Type 1620 Megohmmeter is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.

Components such as transformers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor.

- Resistance — 0.1 megohms to 4,000,000 megohms.
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- Accurate — plus or minus 5% on all ranges.
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OTHER MEGOHMMETERS AVAILABLE

Type 1620C MEGOHMMETER — a type 1620 with additional circuitry for testing capacitors.
Type 1020B MEGOHMMETER — a 500 volt fixed test potential. Range 1 megohm to 2 million megohms.
Type 2030 PORTABLE MEGOHMMETER — battery operated 500 volt test potential. Range 1 megohm to 10 million megohms.

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.
1700 WEIRFIELD ST., BROOKLYN (RIDGEWOOD) 27, N.Y.

NEW PRODUCTS

Tesamoll Urethane Foam Tape. This product, with a wide diversity of uses both domestic and industrial, is being presented and introduced as an important contribution to comfort and convenience, by United Mineral and Chemical Corporation, 16 Hudson St., New York, N. Y. Essentially, this is a urethane plastic foam, backed by a pressure-sensitive, highly tenacious adhesive protected by tissue, easily removed for application. It comes in rolls of ¼-inch and ⅜-inch widths. For industrial purposes, it can be produced in wider and thicker units to meet specific requirements. Write to the company for complete information and samples.

Laminagage Production. Production of a scientific instrument, designed for the precise and nondestructive measurement of the thickness of coatings and platings on base materials, is announced by Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. Known as the Glennite Laminagage, Model *FLW-1*, it can be used for the thickness measurements of metallic film or foil and is said to be able to detect surface and subsurface cracks in smooth and rough coatings, flat stock, or plate and tubing. In addition, it can be used to measure coating thicknesses of odd shaped pieces and on assembly lines where the thickness of coatings must be continuously monitored. The Laminagage is produced under patent rights held by the General Motors Corporation.

Vehicular Desk. This 8-inch by 12-inch aluminum constructed desk is highly flexible and adjustable. A 1-inch deep basket is welded to the underside and the

spring wire mounted-in pencil holder retains completed papers in the basket. A sturdy clip at the top of the desk holds paper work in delivery sequence. The desk slips off the mounting bracket so driver may take it to another location. For further information contact Product Development Corporation, Post Office Box 38, Mt. Ephraim, N. J.

Extremely Thin Teflon Tape. A thermal curing pressure-sensitive Teflon tape only 0.002 inch thick over all has been announced by The Connecticut Hard Rubber Company, 407 East St., New Haven 9, Conn. Called *Temp-R-Tape C*, it is designed primarily for electrical insulation, particularly where a high dielectric, extremely thin, easy-to-apply insulation is desirable such as in miniature electronic components. The tape provides 2,750 volts per mil dielectric strength and has an operating temperature range of —100 F to +500 F.

Four-Channel Stereo–Monaural Magnetic Recording Head. A magnetic head for tape recorders which records and plays four channels on a standard ¼-inch tape has been developed by Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. The unit has two in-line tracks that permit interlaced operation. The new tape head, called the *TR-48*, actually doubles the recording time of both monaural and stereophonic tapes. At the same time, it is completely compatible with present tapes.

Ceramic Coil Forms Line. Designed for both military and commercial applications, National's new line of ceramic coil forms is comprised of 5 standard sizes, each is available with or without terminal collars, and each terminal collar accepts up to four terminals per collar. All materials used are in accordance with military specifications. An internal, preset torque spring positions and locks the adjusting cores, thus keeping coils tuned as set, even under severe vibration and shock. For full specifications write, phone, or wire National Company, Inc., Malden 48, Mass.

Washing and Rinsing Ultrasonic Unit. A self-contained ultrasonic installation for cleaning, immersion, or spray rinsing of hospital or industrial equipment is now available from Branson Ultrasonic Corporation, 40 Brown House Rd., Stamford, Conn. The Model *H-50* Sonogen (registered trade mark) cleaner will process surgical instruments from several operations at one time, or handle the equivalent in badly soiled industrial parts. Cleaning takes only a few minutes, with minimum operator attention. For more information on the Model *H-50* Sonogen, or other ultrasonic cleaning equipment, write to Branson Ultrasonic Corp., 40 Brown House Rd., Stamford, Conn. In Canada, write to Electrodesign, 736 Notre Dame St., W., Montreal, Que., Canada.

Polystrip Cable Added to IRC Line. Continuing its trend toward diversification, International Resistance Company (IRC) introduces Polystrip cable. Polystrip is a lightweight, flexible, multiconductor flat cable for use in electrical and electronic equipment. Polystrip's insulation is a special polyester which can be quickly stripped and the cable solder dipped. Rated at 85 C continuously, it is available in widths up to 51 conductors. For further information write International Resistance Company, 401 N. Broad St., Philadelphia 8, Pa., for Bulletin S-5.

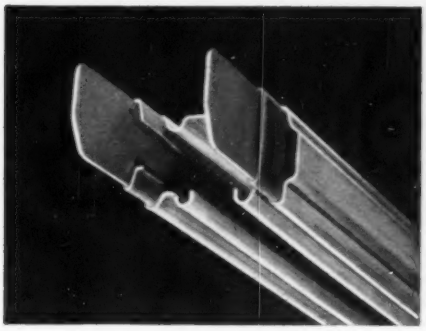
(Continued on page 22A)

New Universal Lighting System—

for flexible, low-cost lighting

Specify efficiency and economy, too. BullDog's new 20-amp Universal Lighting System both feeds and supports lighting fixtures . . . requires no supplementary fusing. Fixtures can be positioned at any spot throughout the entire system . . . are quickly and easily moved to meet changes in lighting requirements. No rewiring or electrical downtime, either

Listed by Underwriters' Laboratories, this new Universal Lighting System assures maximum flexibility at minimum cost. Check its many advantages. Consult your electrical distributor or BullDog field engineer. Or write BullDog Electric Products Co., Detroit 32, Michigan. © BEPCO



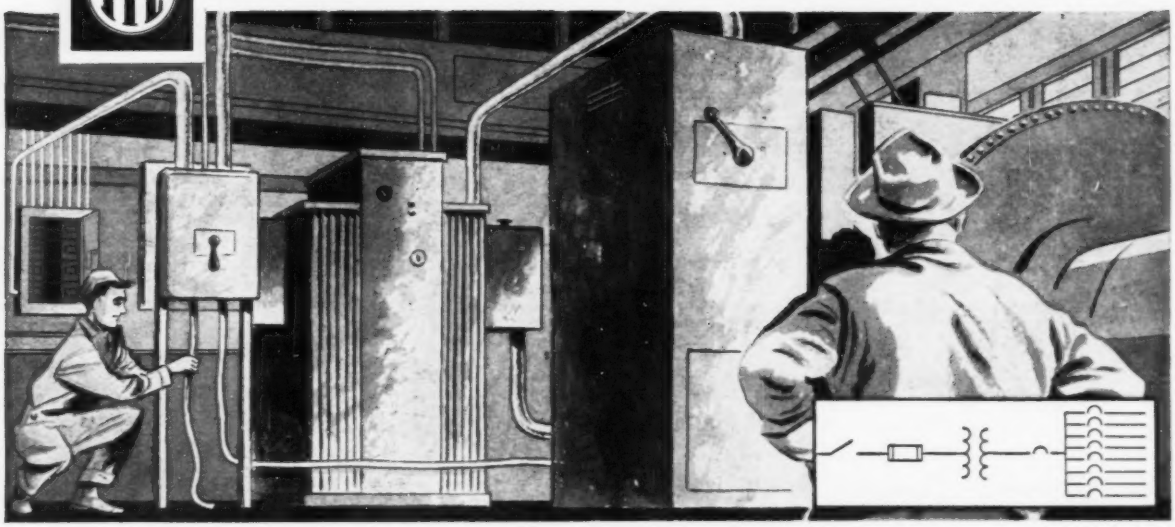
CROSS SECTION of new, low-cost 20-amp Universal Lighting System. Movable weight supports and twistout plugs speed rearrangement, addition or removal of fixtures, eliminate rewiring and electrical downtime.

BULLDOG

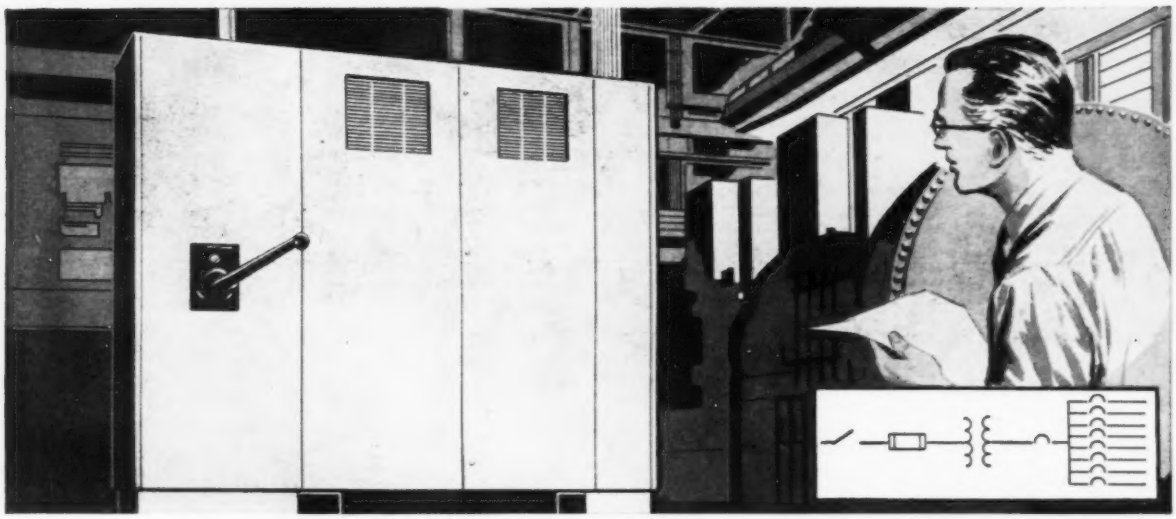
BullDog Electric Products Company, Division of I-T-E Circuit Breaker Company, Detroit 32, Mich. *BullDog Export Division:* 13 East 40th St., New York 16, N.Y. *In Canada:* BullDog Electric Products Co. (Canada) Ltd., 80 Clayson Rd., Toronto 15, Ont.

HEAT BETTER ELECTRICALLY

TRANFO-UNITS



WHY BUY AN EYESORE?



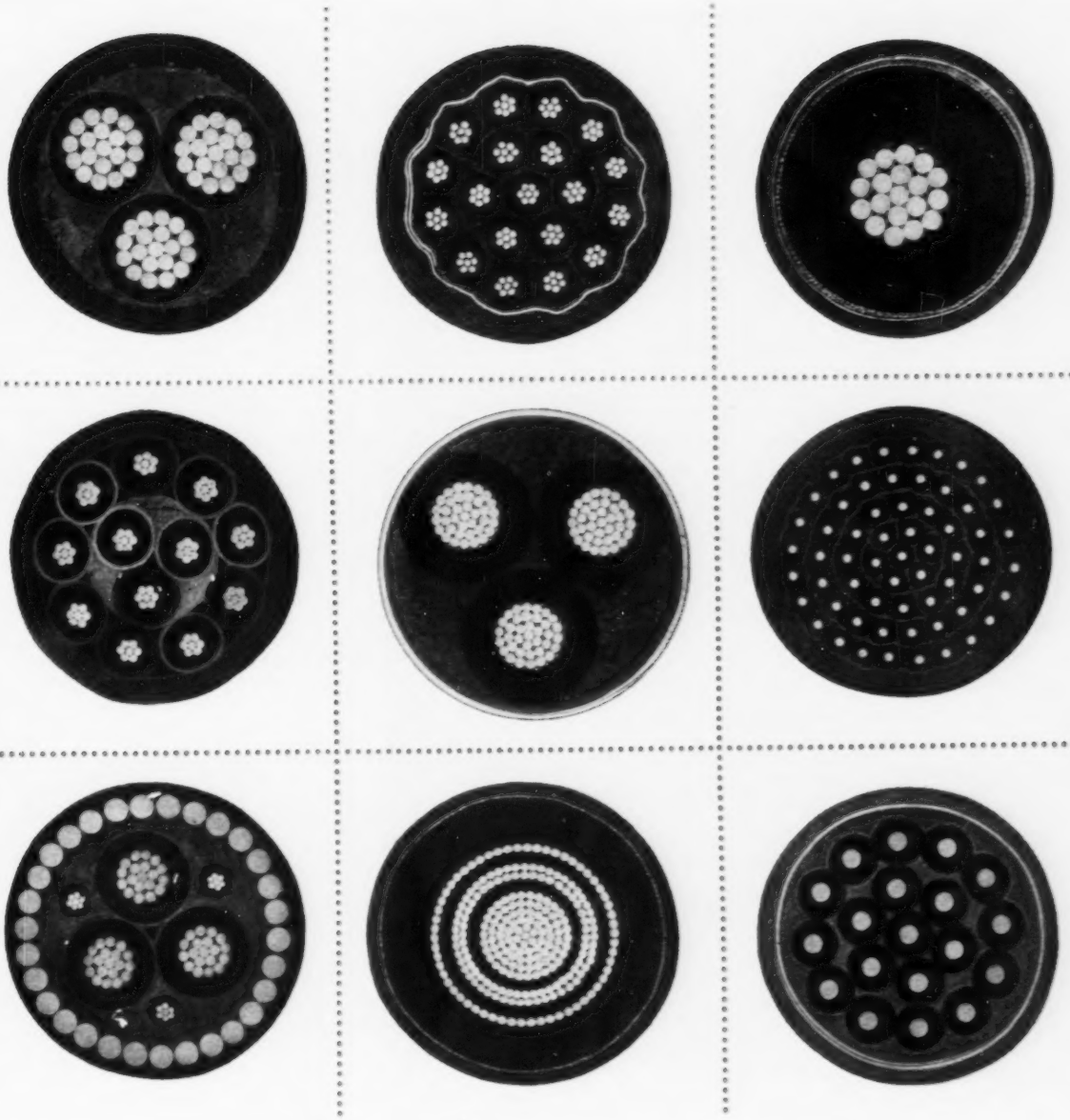
A TRANFO-UNIT COSTS NO MORE

It's neat, compact and completely self-contained—a practical, economical way to bring in your electric power at the low-cost higher voltage. You get the transformer, primary disconnect, and secondary protective devices all included in one neat, safe package.

The I-T-E Tranfo-Unit costs no more than hodgepodge arrangements of assorted gear. But it's so much more satisfactory. You place one order . . . that saves time and trouble. It comes complete . . . that saves extra engineering. It's delivered in one piece . . . that saves installation labor.

For supermarkets, schools, office buildings, factories and many other applications, the I-T-E Tranfo-Unit is ideal. Available in a wide range of capacity ratings. Get all the facts now. Write I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA



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—take advantage of the unique properties of Kerite insulation. Let a Kerite engineer explain why no other cable can equal Kerite's performance in actual service, dependability, and long-time economy. Kerite cables are designed for a variety of applications and operating conditions, and are available in forms and finishes best adapted to your requirements. Be sure. Specify Kerite.

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KERITE CABLE

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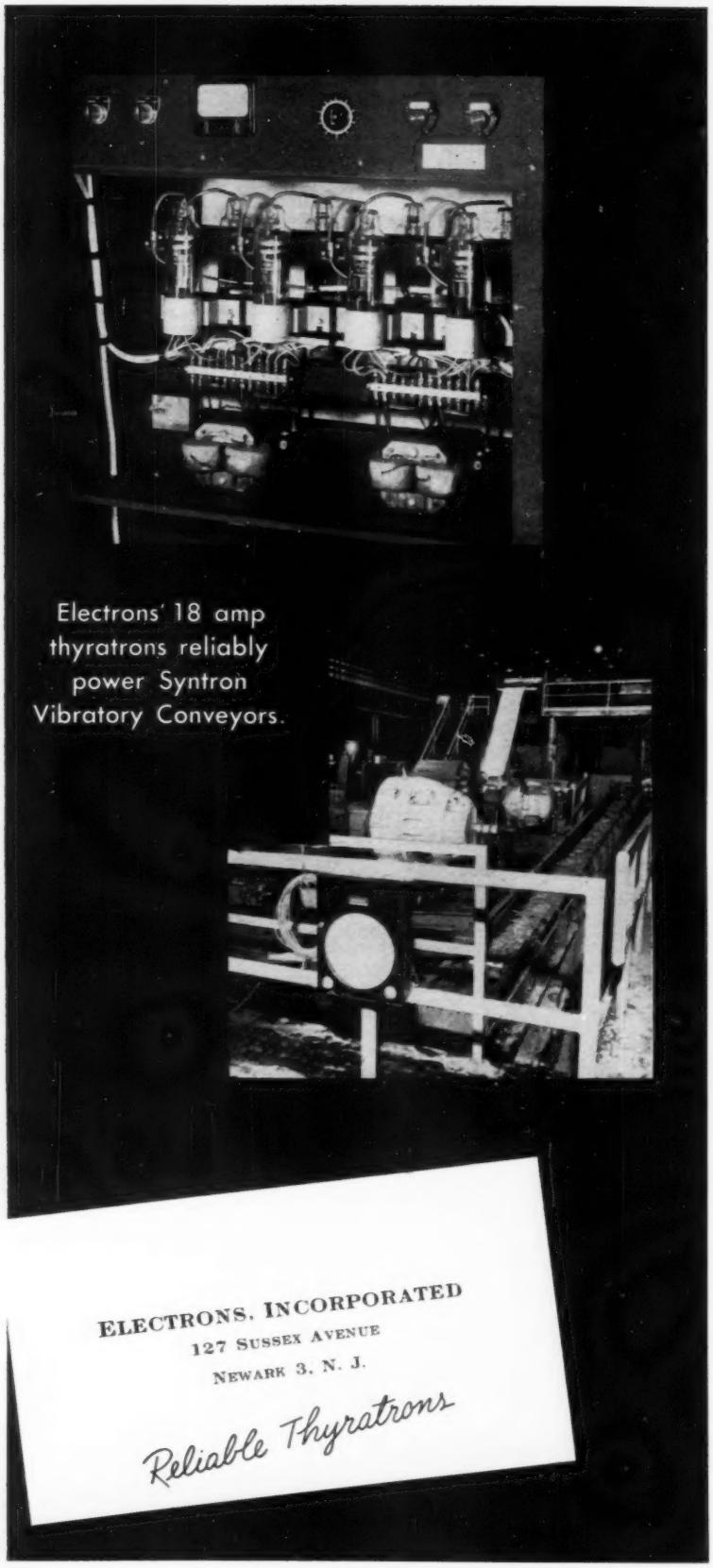
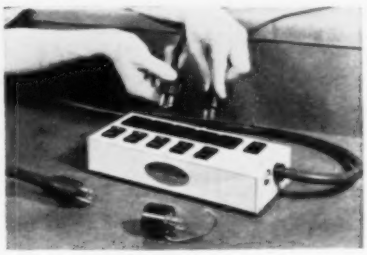


New Products

(Continued from page 18A)

Stable Millisecond Delay Lines. A new range of acoustic delay lines provide delays up to 5 milliseconds and operating frequencies up to 1 mc, with temperature coefficients of less than 5 parts per million per degree centigrade. The lines are available in four packages, to any specified delay in the range 20-5,000 microseconds, with a ±4 microsecond adjustment available to the user. The packages can be supplied complete with transistor input and output amplifiers. The shorter lines can be supplied with taps at specified positions. When used as a digital storage device, the L40 lines, 5 milliseconds long, operating at 500 kc, can store 2,500 bits, or any shorter line can be supplied for a specific bit capacity. In analogue application, the lines can be operated with modulated carriers up to 1 mc/s, with a band width ±25% of carrier frequency. Contact Ferranti Electric Inc., Electronics Division, 95 Madison Ave., Hempstead, L.I., N.Y., for further information.

Five-in-One Control. Greater convenience and safety for laboratory and experimental setups is offered by a device that provides, from any single a-c outlet, five overload-protected and safety-grounded a-c outlets. Signal generators, measuring equipment, and power supplies to the test setup, can all be plugged into the new five-in-one control. Each of the five outlet sockets has a 15 ampere on-off switch, accepts both 3-prong grounding plugs and conventional 2-blade plugs. An instant reset circuit-breaker trips at 15 amperes, protecting equipment that is plugged into the



five-in-one control, and eliminating the cost and nuisance of replacing fuses. A bulletin describing the five-in-one control is available from the manufacturer, Arthur S. LaPine and Company, 6001 S. Knox Ave., Chicago 29, Ill

High Voltage Miniature Vacuum Relay. A vacuum relay for radar pulse forming networks, and for aircraft r-f and d-c circuits where high voltage insulation is required has been announced. Only 2½ inches long and 1¾ inches in diameter, it has a voltage rating of 10 kv and a continuous current rating of 15 amperes rms. It is manufactured and distributed by Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Calif.

(Continued on page 30A)

WILEY BOOKS

1. ANALYTICAL DESIGN OF LINEAR FEEDBACK CONTROLS

By GEORGE C. NEWTON, Jr., LEONARD A. GOULD, and JAMES F. KAISER, all of the Massachusetts Institute of Technology

Shows how to achieve analytical solutions of practical control problems, and demonstrates techniques through use of simplified models and constraints. Presents the results of the authors' extensive research on the analytical design method, showing how such factors as input noise, disturbances, non-minimum phase fixed elements, and saturation tendencies in fixed elements place definite bounds on the performance that can be achieved in linear systems. The authors have consolidated the literature in the field so as to point up the practical utility of analytical design theory.

1957 419 pages Illus. $12.00

2. NETWORK SYNTHESIS—Volume I

By DAVID F. TUTTLE, Jr., Stanford University

Covers networks with two terminals. Features a three-step procedure:—obtaining a working knowledge of the properties of networks; investigating ways of approximating desired behavior; and carrying out the actual synthesis of networks to achieve such attainable ends.

1958 1175 pages Illus. $23.50

3. SWITCHING CIRCUITS AND LOGICAL DESIGN

By SAMUEL H. CALDWELL, Massachusetts Institute of Technology

Treats the methods of handling problems of circuit synthesis, and presents principles of switching circuit design necessary for a knowledge of the complex applications of switching theory.

1958 686 pages Illus. $14.00

4. PRINCIPLES OF NOISE

By J. J. FREEMAN, University of Maryland

Discusses the principles, facts, and techniques used in noise analysis. Deals with such topics as probability, stationary random processes and their transformation, power spectra, noise temperature, input signal-to-noise ratio, output signal-to-noise ratio, minimum detectable signal, etc.

1958 299 pages Illus. $9.25

5. TELEVISION IN SCIENCE AND INDUSTRY

By V. K. ZWORYKIN, R.C.A.; and E. G. RAMBERG, L. E. FLORY, both of the RCA Laboratories

Explores the general function of industrial, or closed-circuit, television, and describes the tools which have been developed to realize it.

1958 300 pages Illus. $10.00

6. AUTOMATIC PROCESS CONTROL

By DONALD P. ECKMAN, Case Institute of Technology

Treats the important principles of automatic control, emphasizing block diagrams and frequency techniques in process control.

1958 368 pages Illus. $9.00

7. NOTES ON ANALOG-DIGITAL CONVERSION TECHNIQUES

Prepared by Staff Members of the M.I.T. Servomechanisms Laboratory; edited by ALFRED K. SUSSKIND, M.I.T.

Includes: the theory of sampling, quantizing, and coding; analysis and evaluation of basic coding and decoding methods for electrical and mechanical analog quantities; and application of basic principles in a digital flight-test instrumentation system. A Technology Press Book, M.I.T.

1958 410 pages $10.00

8. SYNTHESIS OF PASSIVE NETWORKS

By ERNST A. GUILLEMIN, Massachusetts Institute of Technology.

A practical discussion of network linear synthesis. Covers both the approximation problem and the realization techniques, and includes all fundamental theory and methods.

1957 741 pages 466 illus. $15.00

9. CERAMIC FABRICATION PROCESSES

Edited by W. D. KINGERY, M.I.T. With 22 contributors

Information on ceramic research, development, and production, based mainly on 1956 M.I.T. Special Summer Program in Ceramics. Covers: Slip Casting; Pressure Fabrication; Plastic Forming; Drying and Firing; Some Special Processes; and Ceramic Microstructures. A Technology Press Book, M.I.T.

1958 235 pages Illus. $9.50

10. THE GENERAL THEORY of ELECTRICAL MACHINES

By BERNARD ADKINS, Imperial College, London

Presents a general theory applicable to all types of electrical machines. Although analytical in character, the book emphasizes and illustrates the application of the analysis to practical problems.

1958 236 pages Illus. $8.00

11. AN INTRODUCTION TO SEMICONDUCTORS

By W. CRAWFORD DUNLAP, Jr., Bendix Aviation Corp.

Surveys all the important aspects of semiconductors, from research to devices. Covers basic concepts, properties of materials, methods of measurement, and applications.

1957 417 pages 268 illus. $11.75

12. IDEAS, INVENTIONS, AND PATENTS How to Develop and Protect Them

By ROBERT A. BUCKLES, New York Bar

Answers the questions most frequently asked:—what to do when you get an idea for an invention; how to assure yourself of maximum protection; how to avoid costly mistakes.

1957 270 pages Illus. $5.95

13. PROGRESS IN SEMICONDUCTORS—Volume II

Edited by ALAN F. GIBSON, R. E. BURGESS and P. AIGRAIN

The latest information on important aspects of semiconductor research by 13 top authorities.

1957 280 pages Illus. $10.50

14. TECHNICAL REPORT WRITING

By JAMES W. SOUTHER, University of Washington

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RUBBER—Insulated Control Cables			
Rubber-Insulated 600-Volts	The standard Anaconda rubber control cable—with excellent moisture resistance, heat stability and long-aging characteristics.	General-purpose and station control requirements of utilities and industrials.	Can be installed aerially, in conduit, underground in ducts – or buried directly in the earth.
Ozone-Resistant Rubber-Insulated 600-Volts	An ozone-resistant control cable also possessing proved moisture resistance, heat stability and long-aging characteristics.		
THERMOPLASTIC—Insulated Control Cables			
Polyethylene-Insulated 600-Volts	A standard Anaconda thermoplastic control cable with excellent moisture and chemical resistance. Highly resistant to electro-endosmosis. A long-lived cable.	General-purpose control requirements of utilities and industrials.	Can be installed aerially, in conduits, underground in ducts—or buried directly in the earth.
DENSHEATH® Insulated 600-Volts	A standard Anaconda thermoplastic control cable with excellent moisture and chemical resistance. Long-aging performance.		
Anaconda Type PND* Polyethylene-Insulated – Nylon Conductor Cover 600-Volts**	An approved control cable with dependable chemical and abrasion resistance. Features small diameter. Long-aging properties.	General-purpose control requirements of utilities and industrials where space is a limiting factor.	Can be installed aerially, in conduit or underground in ducts.
Polyethylene-Insulated 1000-Volts	A thermoplastic control cable excelling in moisture and chemical resistance. Features heavy insulation thickness. Long-aging characteristics.	Station control requirements of utilities and industrials.	Can be installed aerially, in conduit, underground in ducts – or buried directly in the earth.

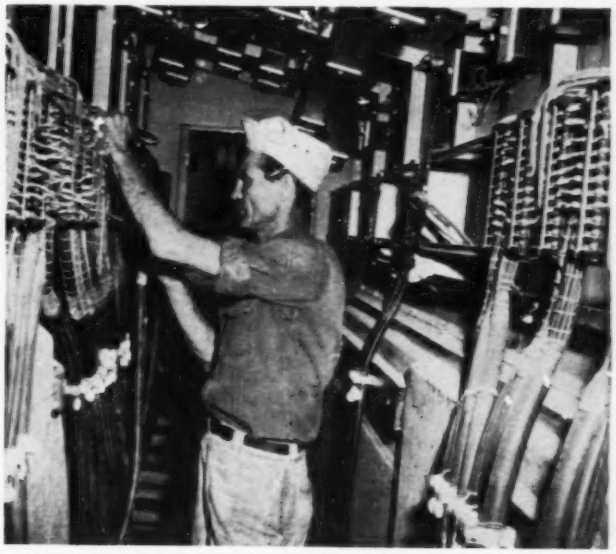
**IPCEA voltage rating is 300 volts.
*Trademark

Lead sheaths are furnished on rubber-insulated control cables if requested.
Interlocked armor is available for all types of control cable.

with these Anaconda Control Cables

Anaconda's Type ANW-Rubber-Insulated Control Cable. High-quality product offering peak reliability, outstanding heat resistance. Cable is also highly resistant to moisture, acids, alkalies, other chemicals. Unusual overload capacity and long-aging characteristics. Individual conductor covering and over-all jacket of neoprene.

Anaconda Thermoplastic Control Cable Multiple-use. Can be installed aerially, in conduit, underground in ducts, or buried directly in earth. Available with polyethylene (600 or 1000 volts) or Densheath* vinyl resin (600 volts) insulation and Densheath over-all jacket. Densheath jackets over polyethylene-insulated conductors on request.



Butyl-Insulated Control Cable. Special ozone-resistant control cable. Individual conductor covering and over-all jacket of neoprene provide maximum insurance against moisture and mechanical injury.

Anaconda Type PND Control Cable. For general-purpose uses where space is a limiting factor. Allows installation of a 12-conductor cable in conduit carrying a 6 or 7. Individual conductor covering of abrasion-, oil- and gasoline-resistant nylon.

Permanent Full-Color Coding on rubber cables, by means of Anaconda's rubber-base coating, assures quick and positive circuit identification. Coding by surface printing, which conforms to IPCEA standards, also available. On thermoplastic cables, full-color coding with pigmented insulation and surface printed coding are likewise offered.

For full information on any of Anaconda's complete line of control cables – including cables engineered for more specialized control requirements – see your Anaconda distributor or the Man from Anaconda. A comprehensive technical booklet on Anaconda Control Cables is yours for the asking. Write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York.

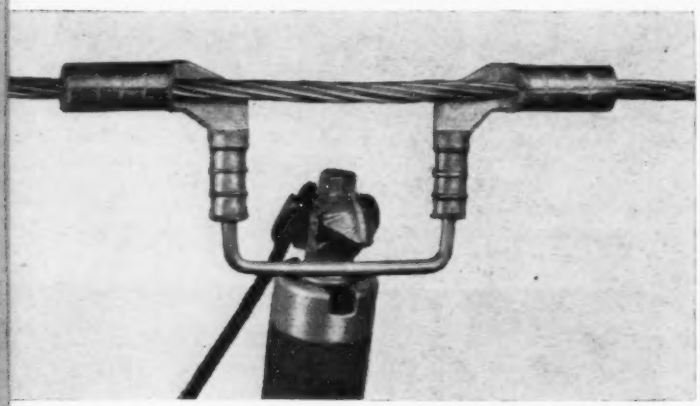
*Reg. U.S. Pat. Off. 58329

LIVE BETTER ELECTRICALLY

SEE THE MAN FROM **ANACONDA**®
FOR **CONTROL CABLE**

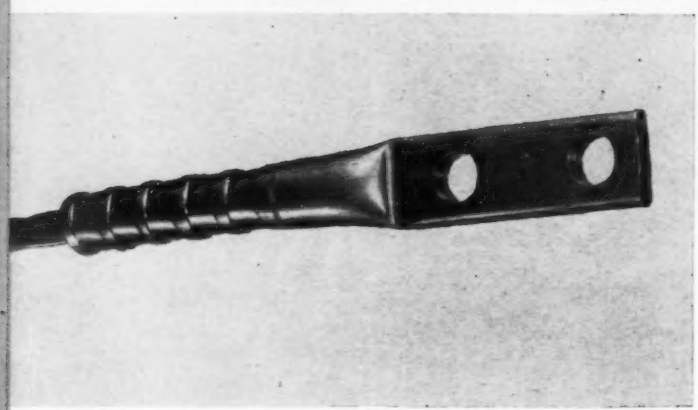
Kearney's compression program

Added versatility and increased application with existing tools—that's what an investment in Kearney Compression can mean for your system. Besides the basic connections—Squeezons, Serv-En Service Entrance Sleeves, Tension Sleeves and others—you receive the advantages of ever widening tool flexibility as Kearney Engineers continue to develop and introduce new Compression Fittings to the field.



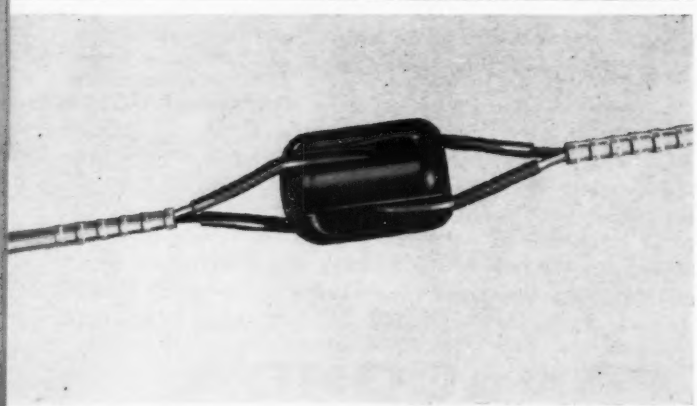
KEARNEY L Squeezon Stirrup

Line side connections are outside the basket—sufficient clearance for either the hydraulic or mechanical tool. The three inch dimension between the line and stirrup makes the unit neat and compact—hot line clamps are readily installed. Unit may be completely covered with line guards.



KEARNEY Compression Terminal

Kearney Compression Terminals provide an efficient method of connecting aluminum conductors to terminal pads. Flaring of strands possible with conventional terminal pads is eliminated. The strands are retained in an aluminum sleeve. Terminals have NEMA 1¾" bolt centers. May also be used as disconnectable jumpers around double dead-ends. The sleeves are filled with Kearnalex Contact Aid and capped and will take conductor sizes from 1/0 to 397.5 MCM 18/1 ACSR.



KEARNEY Insulated Splice

The Insulated Splice was designed primarily for splitting secondaries into shorter sections where additional transformers have been installed and for series street lighting applications. No changes in existing construction are required. Designed for copper, aluminum and ACSR connections, this splice features one piece construction, tension-type sleeves, insulated stainless steel bails and a high strength strain insulator. Splice can be installed with Kearney Hydraulic or Mechanical Tools. ACSR and aluminum sleeves are packed with Kearnalex Contact Aid and plastic capped.

JAMES R. KEARNEY CORPORATION • General Offices: 4224-42 Clayton Ave., St. Louis 10, Mo.

pays extra dividends

KEARNEY INSIDE TAPERED COPPER SLEEVE

A completely new, cost-cutting design—another Kearney "dividend"—permanent, positive, full tension splicing of energized conductors with standard Kearney tools and dies.

ADVANTAGES—

1. **Metallizing process**—copper sleeve is sprayed internally with conductive metal to assure maximum holding power and high conductivity.
2. **Full Inside Taper**—design assures ease of insertion of hot conductors—also relieves stress, due to vibration, at the extremities of the sleeve.
3. **Shorter Length** means less installation time, fewer crimps and no sacrifice of holding power—sleeve is more easily stored.
4. **Clearly marked** with conductor and die sizes.

KEARNEY WH-1 TOOL

A rugged, reliable hydraulic tool which expedites the installation of Kearney compression fittings and sleeves. Hi-speed, two-valve pump permits fewer strokes for full compression—exerts 21,000 pounds thrust. The narrow "C" head permits full visibility of the working area. Balanced weight enables the lineman to position the tool quickly and accurately for each indent. Interchangeable, insulated wood handles with extra length are available for working higher voltages.

FOR BETTER CONSTRUCTION—SAFER MAINTENANCE

Specify Kearney Products

PLANTS AT: ST. LOUIS • FAYETTEVILLE, ARKANSAS • SHENANDOAH & CLARINDA, IOWA • GUELPH, ONTARIO, CANADA

INTERLOCKED ARMORED CABLE

For Power Distribution in New Plants or in Modernizing Old Plants For more current capacity than cable in conduit or other armored cable, *specify and buy Rockbestos A.V.C.* . . . for easy installation on racks or hangers beneath the ceiling or next to walls, *specify and buy Rockbestos A.V.C.* . . .

. . . To eliminate costly conduits and ducts . . . to save important dollars on materials and installation time, to permit quick, easy repairs, *specify and buy Rockbestos A.V.C.* . . . All interlocked armored cables are not alike . . . and, for maximum dollar-savings and maximum performance be sure to *specify and buy Rockbestos A.V.C.* Interlocked Armored Cable — the superior AVA Cable.

Write now for the new Rockbestos manual which gives the application and design data to help you *specify and buy Rockbestos A.V.C.*

ROCKBESTOS PRODUCTS CORPORATION, NEW HAVEN 4, CONNECTICUT
NEW YORK • CLEVELAND • DETROIT • CHICAGO • OAKLAND • PITTSBURGH
ST. LOUIS • LOS ANGELES • SEATTLE • NEW ORLEANS

ROCKBESTOS A.V.C.

THE SUPERIOR A.V.A. CABLE

Spaulding's TRANSFORMER BOARDS

SPAULDING T Designed with a high dielectric strength for power transformer insulation, SPAULDING T Fibreboard also incorporates high chemical purity, excellent forming quality and mechanical strength, good aging characteristics. Ideal for a variety of applications.

SPAULDING TK A 100% Kraft electrical insulation board for use in dry type air cooled or liquid filled transformers, and as tank liners for power factor correction capacitors, SPAULDING TK is an extremely pure insulation. It will not discolor transformer oil and has a very low power factor, chloride content and conductivity of water extract.

SPAULDING TKR Especially developed for transformer insulation requiring Kraft paper with rag content, SPAULDING TKR is electrically clean and uniform, with high dielectric strength. It is chemically stable, won't discolor transformer oil, and can be punched, bent and formed.

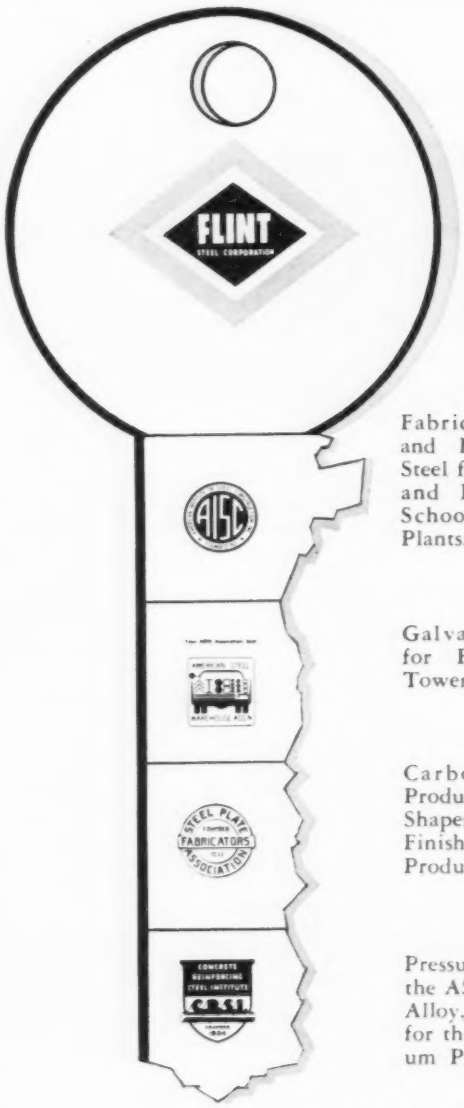
SPECIFICATIONS

	T	TK	TKR
Maximum Sheet Size	96" x 144"	92" x 144"	96" x 144"
Thickness Furnished	1/32"-1/4" (Heavier thicknesses in Laminated Form)	1/32"-1/4"	1/32"-1/4"
Color	Natural Grey	Natural Tan	Natural Grey
Density	.95-1.20	1.00-1.10	.95-1.20
Mullen: per mil	12.0-15 lbs.		12.0-15 lbs.
Tensile — p.s.i. W.G.	9000-11000	420-1350	9000-11000
Tensile — p.s.i. A.G.	3500-4500	140-510	3500-4500
% Water Absorption: 24 Hrs.	90-100		90-100
Dielectric Strength V/M	150-300	150-350	150-300

For More Information, Contact

SPAULDING FIBRE COMPANY, INC.

305 WHEELER STREET, TONAWANDA, NEW YORK



Fabricated Structural Steel and Fabricated Reinforcing Steel for Bridges, Commercial and Industrial Buildings: Schools, Hospitals, Power Plants, Coal Washing Plants.

Galvanized Structural Steel for Electrical Transmission Towers and Substations.

Carbon Steel Warehouse Products: Structural and Bar Shapes, Plates, Hot and Cold Finished Bars, Construction Products.

Pressure Vessels fabricated to the ASME Code from Carbon, Alloy, and Alloy Clad Steels for the Chemical and Petroleum Processing Industries.

The key to successful bidding and a source for steel fabricated to your most exact specifications could be any one or all four of Flint's divisions —

Structural and Reinforcing —
Tower and Substation —
Fabricated Plate
and Steel Warehouse.

Structural steel can now be delivered promptly and when required.

for over 40 years

FLINT STEEL CORPORATION
TULSA . . . MEMPHIS

New Products

(Continued from page 22A)

Automatic Door Operator. The many benefits of automatic door operation are put within the reach of everyone by the introduction of a greatly simplified door operator. The entire mechanism is contained in a single, ingenious, compact unit, not much larger than an ordinary door check. Installation, which can be made in a matter of hours, consists only of attaching the door operator to the door, then making a few simple electrical connections. The door operator is, therefore, as readily applied to existing doors as to new construction. Send for new bulletin number *PD 568*, Electronics Corporation of America, Public Relations Department, One Memorial Drive, Cambridge 42, Mass.

Areagraph. A method of performing the same basic functions as a planimeter, considerably faster and at a fraction of the cost, has been introduced by the Charles Bruning Company, Inc., 1800 Central Rd., Mount Prospect, Ill., under the trade name "Areagraph." It is an inexpensive method of measuring quickly and accurately any irregularly shaped areas on maps, drawings, charts, photographs, and plane objects. Areas are easily measured by placing an Areagraph overlay, a transparent film printed with a pattern of

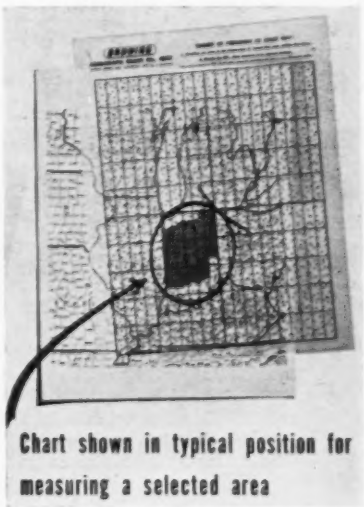


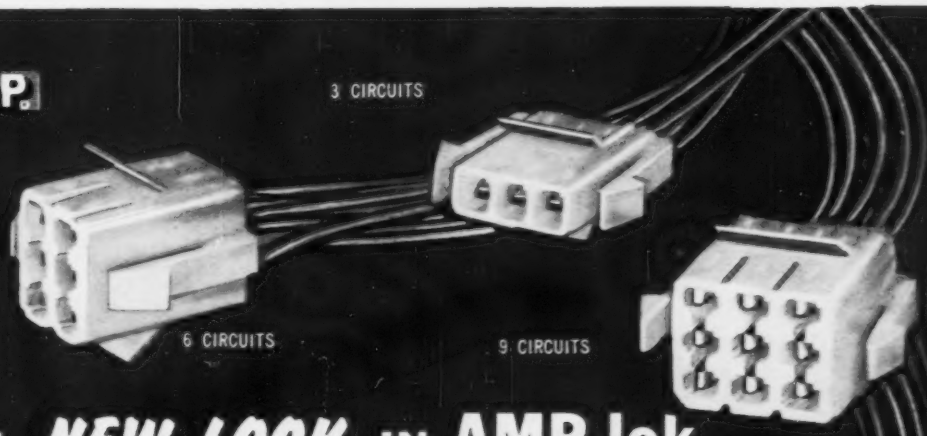
Chart shown in typical position for measuring a selected area

Courtesy Bruning.

grids and dots, over the area to be measured. The dots falling within the area to be measured are counted and then divided by a simple factor printed on the overlay. The answer is given in square inches. The dots are located in accordance with a statistical method which is mathematically proved. Areagraphs are available in sets of three, one chart for each of three predetermined degrees of accuracy, 85%, 90%, and 97%. Free literature is available by writing directly to the company.

(Continued on page 34A)

AMP

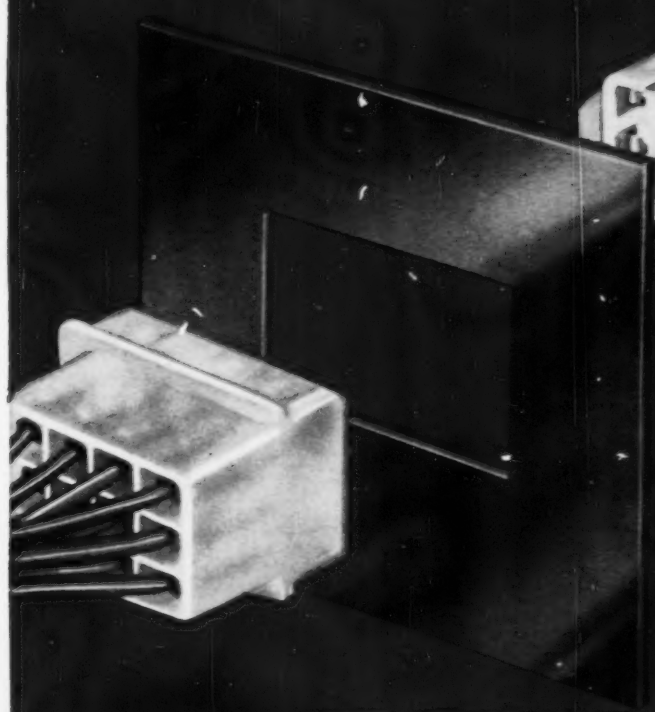


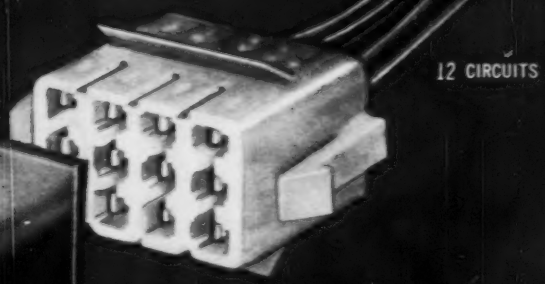
THE *NEW LOOK* IN AMP-lok

Now . . . connect 3, 6, 9 or 12 circuits simultaneously with the AMP-lok multiple connector and a simple push of the fingers.

All units are self-anchoring and require no supplementary mounting parts in through panel multiple connector applications.

AMP-lok can be used as a safe, free-hanging multiple connector also.





AMP-lok obsoletes all it replaces because of the following design features:

- contacts are identical . . . self cleaning . . . recessed for safety
- finger grip engagement and disengagement
- polarized to eliminate circuit error
- wide panel thickness accommodation—one simple mounting hole required
- color coding available

Additional literature and samples available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

100% Tiger Brand. Both main feeders and distribution cables are Tiger Brand. The main feeders are 3-conductor, paper-insulated, lead-sheathed cables. Customer wrapped a fireproof tape over the lead sheath.

USS Tiger Brand Electrical Wire & Cable

A standard cable for every special job

- Asbestos Wire and Cable
- Mold Cured Portable Cord
- Shovel & Dredge Cable
- Paper & Lead Cable
- Varnished Cambric Cable
- Interlocked Armor Cable
- Special Purpose Wire & Cable
- Aerial, Underground and Submarine Cable

At Universal Atlas Cement Company . . .

They looked ahead to solve tomorrow's power problem

TWO OF THE LARGER CEMENT KILNS in the country—each 360 feet long by 11 feet in diameter—are busy turning out cement at Universal, Pennsylvania. It takes a lot of electric power to run this plant of Universal Atlas Cement Company. But power is one thing they have plenty of—now and for the foreseeable future.

A new distribution system, designed jointly by Universal Atlas and Duquesne Light Company, was installed in 1952. It not only can handle today's peak loads of 8,976 kw, but also can easily handle a 50% expansion in productive capacity and power demand.

A 60-foot drop between the outdoor substation and the plant distribution center presented the possibility of excessive oil migration to the bottom of the rise. Special fittings shown in this manhole permit easy checking of oil pressure to insure safety.

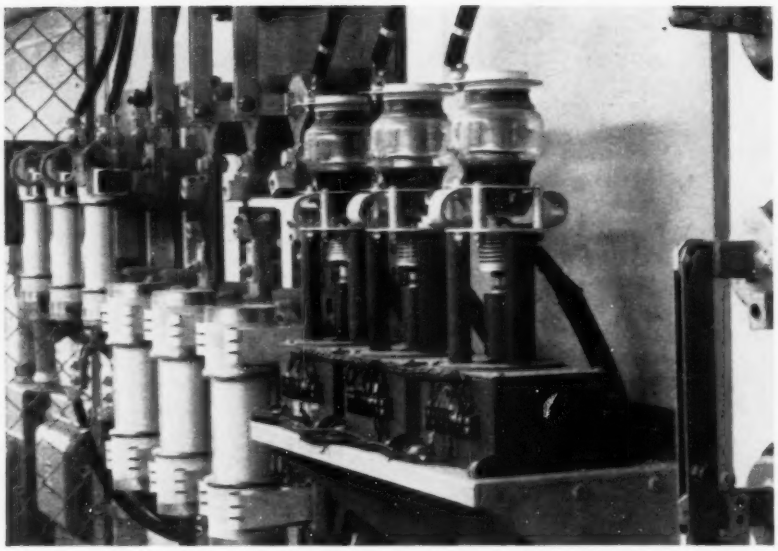
Tiger Brand Electrical Cable plays an important part in this look-ahead planning. Main power feed to the plant comes through 500-MCM, paper-insulated, lead-sheathed USS Tiger Brand Electrical Cable. All distribution cables are also Tiger Brand. At the time of installation, Universal Atlas applied a fireproof asbestos tape over the lead sheath. The installation has been trouble-free and is expected to last the life of the plant.

The tough jobs are the ones for which Tiger Brand Cables are made. Overhead, underground, underwater, anywhere that service is hard and specifications severe, Tiger Brand is the cable you need. Write for complete facts. Or call our nearest sales office. American Steel & Wire, General Offices: Cleveland 13, Ohio.

USS and Tiger Brand are trademarks

American Steel & Wire
Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors
United States Steel Export Company, Distributors Abroad



2400 volt overload protection for General Electric's new 50kw broadcast transmitter in service at station XEAK Tijuana, Mexico.

One Cycle CIRCUIT BREAKER

For fast, reliable overcurrent protection with JENNINGS VACUUM RELAYS

Rapid, reliable overcurrent protection was high on the list of design objectives set by General Electric engineers when they built their new BT-50-A broadcast transmitter. Jennings RH4G high voltage vacuum switches mounted as a normally open Model E relay were chosen to provide this protection because they offer:

- Positive interruption at first current zero in ac circuits, limiting arc time to less than 8 ms.
- Simple push-pull mechanical action operated by a 115 vdc solenoid modified to permit fast drop out.
- Contacts sealed in a vacuum so they require no maintenance and eliminate the danger of fire and explosion.

In addition to the normally open vacuum relays as supplied to General Electric, Jennings offers complete overload circuit breaker units composed of a high voltage instantaneous trip overcurrent relay, a normally open vacuum relay, and a control box, any of which may be purchased separately. The overcurrent relay is a highly sensitive trip mechanism with the trip solenoid insulated from ground. Wired to a normally open vacuum switch total mechanical operate times are only 6 to 12 milliseconds from the time the fault current begins to rise until the high voltage switch opens.

Jennings Overload Circuit Breakers are useful in primaries and secondaries either with Jennings High Voltage Overcurrent Relays or with any conventional low voltage overcurrent relay. They can be wired for 3 phase simultaneous operation with electrical interlocks to prevent single phasing.

JENNINGS RADIO MANUFACTURING CORP. • 970 McLAUGHLIN AVE. P.O.BOX 1278 • SAN JOSE 8, CALIF.

Write today for full details on Jennings line of overload circuit breakers for complete protection of delicate electronic equipment.

Jennings RADIO® VACUUM ELECTRONIC COMPONENTS

New Products

(Continued from page 30A)

Burr-Bit for Three Fluted Taps. An addition to the line of Burr-Bit has been announced by Vernon Devices, Inc., with the introduction of the three-fluted Burr-Bit designed to fit three fluted taps. Heretofore, the Burr-Bit was adaptable only on two and four fluted and heli-coil taps. The three-fluted Burr-Bit, like the rest of the line, comes in sizes from no. 6 to ½ inch and will fit existing manufactured taps. For further information, write to Vernon Devices, Inc., 481 E. Third St., Mount Vernon, N. Y.

Scope and Instrument Dolly. Sturdy and easy-wheeling laboratory dolly with an adjustable, inclinable top for accurate, direct reading of test meters and scopes has been developed. The versatile dolly intended for laboratory or shop has a spacious 4.8-cubic-foot storage capacity, including full-size 5¼-inch-deep drawer, and separate shelf with 14¾-inch clearance below the drawer. The roomy dolly top can be set from horizontal to inclines of 10°, 15°, and 20° for optimum instrument-reading angles. A retaining rim around the top assures instrument safety and holds working accessories ready for convenient use. Standard finish is instrument gray baked enamel. Further information may be obtained from the Artisan Metal Works Company, 11400 Madison Ave., Cleveland 2, Ohio.

Shunt-Wound D-C Brake. Availability of a shunt-wound d-c brake has been announced. It is the d-c model of the new Style *HT70* series, offering torque ratings of from 10 foot-pounds through 105 foot-pounds, with both standard and dust-tight, waterproof enclosures available. The brake can be floor mounted or motor mounted on motors utilizing the familiar stub shaft, a standard double shaft extension, or can be easily modified for through shaft applications. This model also retains the desirable unitized construction, single solenoid construction, single-point adjustment for lining wear, visual indication of lining wear, and manual release, automatic reset. As in past models, all normal maintenance can be accomplished with a screwdriver. For additional information contact Stearns Electric Corporation, 120 N. Broadway, Milwaukee 2, Wis.

Highly Specialized Pen Kit. The impressive increase in use of schematic drawing templates has prompted the design of a specialized pen kit intended to wring the last drop of speed and uniformity from them. This kit, Omnigraphos, teams up a fountain barrelled pen with 12 width-set tubular nibs able to draw or match ink lines from 0.3 mm to 2.5 mm, regardless of the curves thrown at it by the most complicated templates. Source: Laramie Chemical Corporation, 290 Main St., Stamford, Conn.

(Continued on page 40A)

No. 6 in a series

Right off the Wire

A computer-controller system is said to be capable of landing 120 jet planes per hour. Human control can average no better than 40 per hour.

Dockside facilities at SIMPLEX' Submarine Cable Division in Newington, N. H. are extensive enough to continuously load two of the largest submarine cable ships simultaneously.

A new plant is reported to cut the manufacturing time of industrial carbon components from eight weeks to eight minutes.

A "building block" technique, using miniature plug-in units, makes it possible to build an electronic computer small enough to go on an office desk.

An iron-aluminum alloy has been made, the behavior of which indicates that there is a relationship between rusting and magnetism.

Some fruit trees have been found to ripen earlier after long exposure to gamma radiation.

At least one of the new "exotic" rocket fuels is being made in solid form and others are expected soon.

A patent has been issued for a radioactive "go-devil" (a device for cleaning pipe lines). If it sticks in a pipe it can be located with a Geiger counter.

It is estimated that malicious damage to street lamps costs New York City a quarter of a million dollars a year. A new plexiglas globe makes this sort of vandalism almost impossible.

Instead of the usual bracing and shoring, inflatable cushions are being used to wedge freight tightly in box cars.

One of the new guided missiles is launched from an automatic base which computes the location of the attacking object, calculates its speed and the proper point for meeting it. It also loads and fires the missile automatically.

A micro-porous synthetic material holds a liquid, such as an ink or lubricant, and gives it off at a controlled rate.

Damage to small delicate parts on a conveyor can be avoided by a new belt that uses permanent magnets to hold the pieces apart.

Glass-reinforced plastics can be strengthened by the use of a special new glass containing copper oxide.

Further information on these news items and on Simplex cable is available from any Simplex office. Please be specific in your requests.

A new wool-like synthetic fiber is water-repellent, quick-drying and less expensive than other synthetics.

A device for measuring the power output of a turbine involves an inner and an outer gear in constant mesh with free space between the teeth. This space is filled with oil on which the pressure can be measured.

Simplex Wire & Cable Co. was the first to adapt interlocked armor (CONDEX) for use with underground cable in 1924.

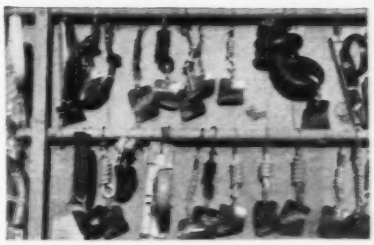
A logging company is using plastic nails to fasten logs together. They neither rust nor damage saw blades.

Paralyzed fingers can be made to move by means of tiny artificial muscles powered by a carbon dioxide cartridge.

Research conducted by two Simplex scientists in the early 1920's resulted in the first truly moisture-resistant rubber insulation. The isolation and removal of the proteins that are always present in natural rubber was the basis of the now famous ANHYDREX family of insulations.

Foamed aluminum is being made for use as a core in sandwich construction.

An electronic device checks the accuracy of aircraft guns without firing them.



Rooftop Laboratory

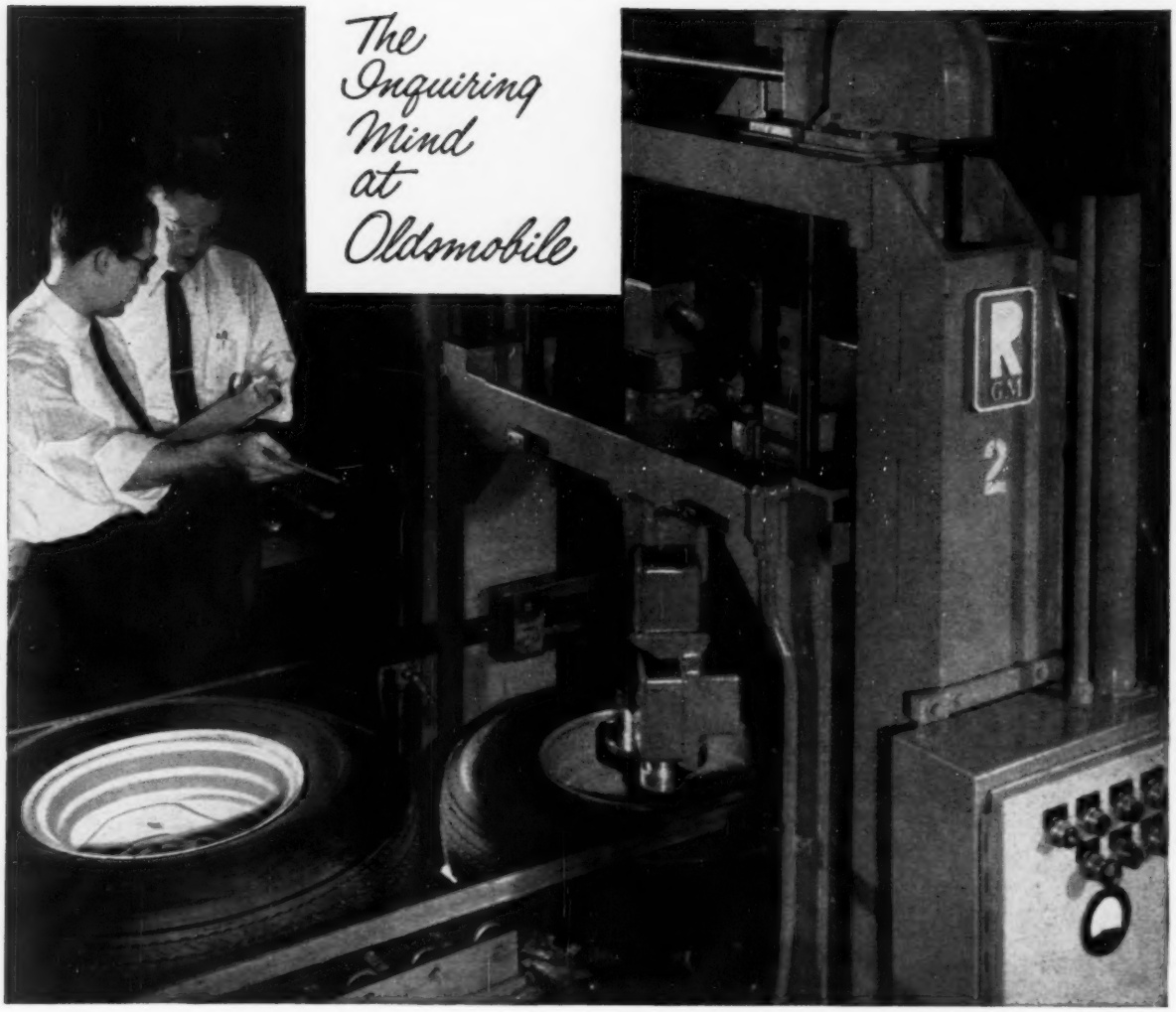
These cable samples, twisted and bent to exert maximum stress on insulations and jackets, are undergoing sun-crack endurance tests atop the Simplex plant at Cambridge. Many of these samples have been exposed to the elements for as long as fifteen years . . . and they haven't cracked yet. This is one example of the many punishing tests which Simplex insulating and jacketing compounds, such as Anhydrex, Thermoplex and polyethylene, are subjected to before they win final approval.

It's all part of a comprehensive system of quality control which has helped make Simplex the leader in cable research and manufacture.

SIMPLEX WIRE & CABLE CO.
Cambridge, Massachusetts and
Newington, New Hampshire

Simplex

"The American manufacturers of transoceanic telephone cables"



no. 3 OF A SERIES

TIPPING THE BALANCE IN YOUR FAVOR

New Olds-developed machine makes wheel balancing three times more accurate!

Out-of-balance wheels and tires are not only a source of annoyance and tire wear, but also in extreme cases, a detriment to safety by causing excessive shimmy at higher speeds.

To virtually eliminate this problem, Oldsmobile engineers, in conjunction with the General Motors Research Section, have developed a machine that automatically balances every wheel and tire with a degree of precision not previously possible on a production basis. With this equipment, balancing is now accurate to 2 inch-ounces, or approximately three times more precise than before.

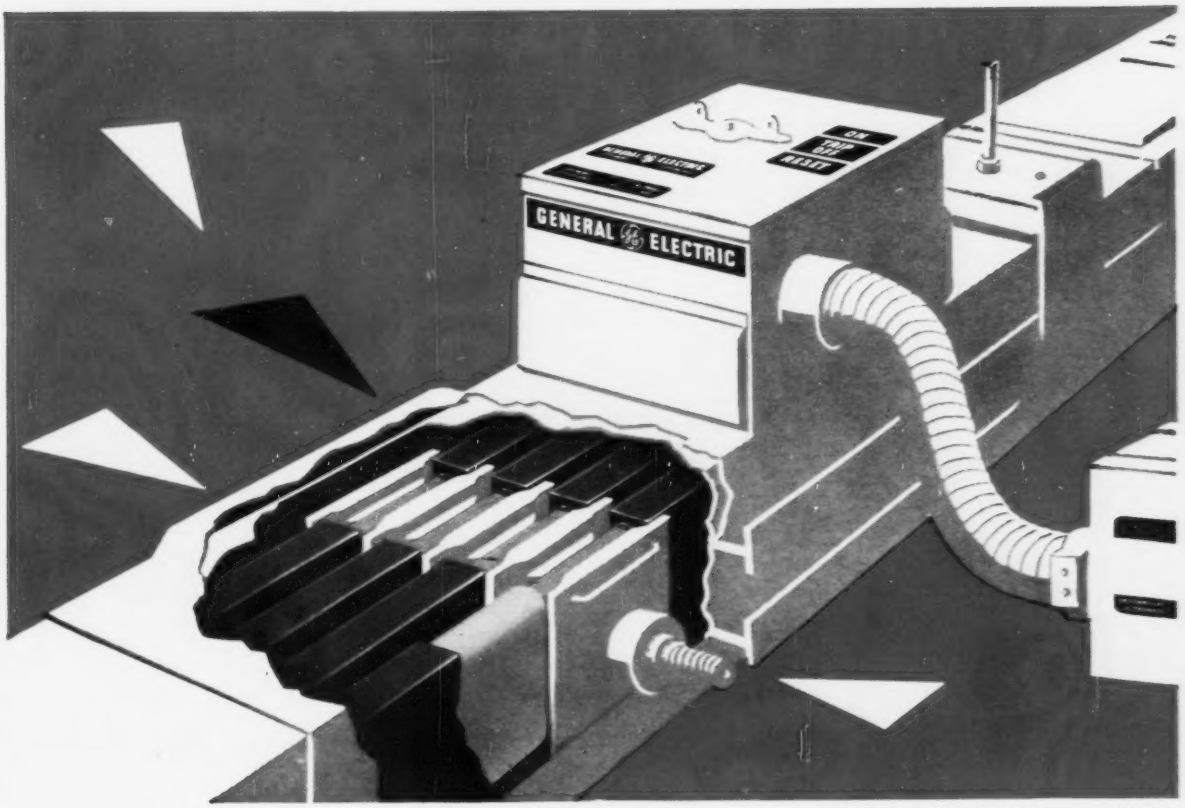
The heart of such accuracy is an automatic electronic computing device. After the tire and wheel are located on a delicate sensing table, supported on an air bearing, four differential transformers signal the out-of-balance to an electronic computor. This computor then resolves the vector forces and a signal of the proper magnitude and direction is transmitted to the stamping head which automatically revolves to the correct location on the wheel. The stamping head then prints the correct weight, accurate to .25 ounce. The entire assembly is then moved to a station where the weights are attached.

It has often been said that "Olds really knows how to put a car together." This reputation grew from a sincere concern for just such little-noticed details. A warm welcome awaits you at your Olds dealer's. He invites you to try a '58 Olds on the road.

OLDSMOBILE DIVISION
GENERAL MOTORS CORP.

OLDSMOBILE

Pioneer in Progressive Engineering ...Famous for Quality Manufacturing



When Enjay Butyl is used as continuous insulation of tubular aluminum conductors, traveling arcs are virtually eliminated, plug outlets are essentially dead-front.

ENJAY BUTYL

helps keep costs low in new Aluminum Busway!

Enjay Butyl is extruded over the full length of the conductors used in General Electric's new Type DE Busway, the first busway designed specifically for aluminum. This new busway incorporates all 22 features that engineers consider important in busway design, yet it is up to 30% smaller and 50% lighter than other busways of comparable rating.

Enjay Butyl rubber is ideal for use as continuous insulation of tubular conductors because of its inherent resistance to ozone and to heat aging. Add Butyl's excellent electrical properties, its vulcanizability and the fact that it is the *lowest cost* rubber on the market—and you'll understand why it was chosen above all other rubbers to do this job.

Every day manufacturers are discovering new ways to use economical Butyl. Find out how Enjay Butyl rubber can cut production costs for you. For further information and expert technical assistance, contact the Enjay Company.

ENJAY BUTYL

Enjay Butyl is the greatest rubber value in the world. It's the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

ANSONIA
Ankoseal®

SUPERVISORY CONTROL & STATION CONTROL CABLES

for Industry, Utility and Mechanized Research Applications

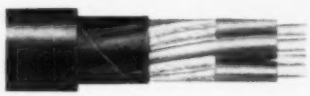
ANKOSEAL Quality Makes The Performance Difference

In telephone cables, in railroad cables and now in supervisory control & station control cables, Ansonia Ankoseal provides the best quality and the latest developments.

Whether your control cable installation calls for heavier insulation to give rugged dependable service on critical circuits or for routine smaller current circuits such as telemetering, pilot wire relaying, etc., . . . an Ankoseal cable will serve you best.

ANKOSEAL has just published a complete catalog on their Supervisory and Station Control Cables. Send for your copy NOW!

ANKOSEAL Type 775-P Supervisory Control Cables, 0-300 Volts.



ANKOSEAL Station Control Cables 0-600, 0-1000 and 0-300 Volts.

THE ANSONIA WIRE & CABLE COMPANY · ASHTON 12, R. I.

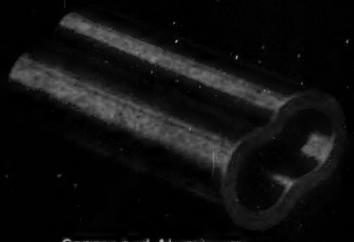
The Oldest Name in Plastic Cables in The Most Modern Plant Devoted Entirely To Producing Plastic Cables

ANSONIA Ankoseal®

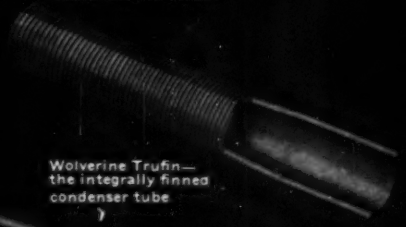
ANKOSEAL Cables Built Up To Quality Not Down To Price

624-7

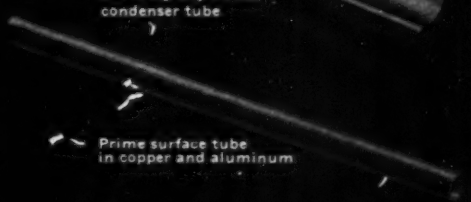
FROM TRANSMITTING KILOWATTS TO TRANSFERRING BTU'S



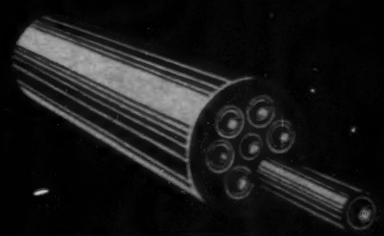
Copper and Aluminum electrical connectors



Wolverine Trufin—the integrally finned condenser tube



Prime surface tube in copper and aluminum



Rigidly quality-controlled tubing for transmission cables

WOLVERINE TUBE PRODUCTS FOR THE ELECTRICAL INDUSTRY

When a manufacturer of transformer oil coolers needs condenser tubing he can obtain exactly what he requires from Wolverine Tube. Wolverine's condenser tube line-up includes both prime surface tubing and capacity-boosting Wolverine Trufin —the integrally finned tube. If, on the other hand, his requirements call for small diameter tubing for transmission line use Wolverine has it, too—in a wide range of wall thicknesses and alloys in both copper and aluminum.

For the production of tubular-shaped parts for electrical use, Wolverine maintains complete fabrication facilities. Included are such techniques as finning, spinning, beading, bending, coiling, extruding, flaring, and expanding—to name but a few of the possibilities. Wolverine copper and aluminum tube is also widely used for fabrication into electrical connectors.

Next time you need tubing—or technical counsel concerning tubing and its uses—remember that the finest in both are available at Wolverine Tube. For the complete story write for your copy of the Wolverine General Products Catalog.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION
In Canada:
CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO., LTD.
UNIFIN TUBE DIVISION

WOLVERINE TUBE
DIVISION OF
CALUMET & HECLA, INC.
17248 Southfield Road
Allen Park, Michigan
Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
Export Department, 13 East 40th Street, New York 16, New York.

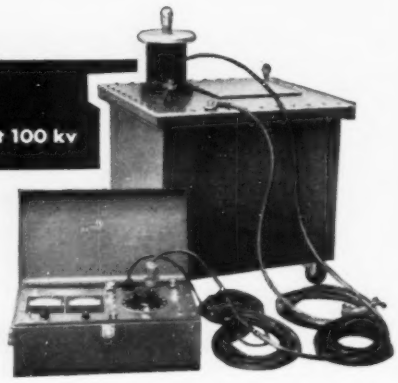
BIDDLE DIELECTRIC TEST EQUIPMENT

. . . for measuring direct current at voltages up to 100 kv when applied to the insulation of generators, transformers, bushings, cable, etc.

New

MODEL 2

current output 6 ma continuous at 100 kv



More and more engineers are leaning to d-c testing with voltages equal to or somewhat greater than equivalent peak alternating voltages. Their experience and increased knowledge and appreciation of the advantages of testing with direct voltage have accelerated the need for test equipment to meet field requirements.

IMPORTANT FEATURES

- Well-designed provisions for utmost safety
- Simple operation and reliable performance
- Excellent output voltage regulation
- Compact, mobile design
- Facilities for voltage and leakage current measurements

IMPORTANT APPLICATIONS

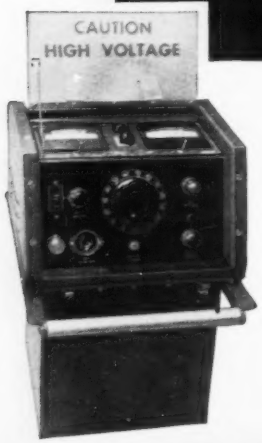
. . . *in development* . . . for testing the d-c dielectric strength of insulating materials and the adequacy of the electric design of insulation in any type of electrical equipment.

. . . *in production* . . . for non-destructively detecting defects in the insulation of electrical equipment due to design, material, and workmanship.

New

MODEL 1-A

3 ma continuous at 40 kv



. . . *in maintenance* . . . for non-destructively detecting unreliable condition of insulation of new or repaired electrical equipment. Preventive maintenance tests on important rotating equipment, cable, switchgear, etc., result in appreciable savings.

For important details regarding these units and information on the subject of high voltage d-c testing *write for our New Bulletin 22-EE.*

B-800

JAMES G. BIDDLE CO.

1316 ARCH STREET • PHILADELPHIA 7, PA.

ELECTRICAL TESTING INSTRUMENTS • SPEED MEASURING INSTRUMENTS
LABORATORY & SCIENTIFIC EQUIPMENT

James G. Biddle Co.
1316 Arch St., Phila. 7, Pa.
Please send me
BULLETIN 22-EE

Name _____
Company _____
Address _____
City _____ Zone ____ State ____

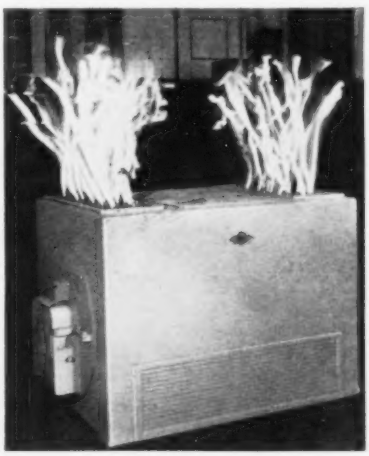
New Products

(Continued from page 34A)

Unitizer. A microfilm printer which permits microfilm users to unitize from original roll film to Actifilm sheet or to Filmsort aperture card or from Filmsort aperture card to Ozacard has been introduced by Microline Products Group, Ozalid Division, General Aniline and Film Corporation, 16 Corliss Lane, Johnson City, N.Y. This versatile new printer, named the Unitizer, reproduces and unitizes in one simple dry operation at minimum cost. Development is handled by any standard ammonia machine or a simple, inexpensive companion tube developer. For price and further information write to the company.

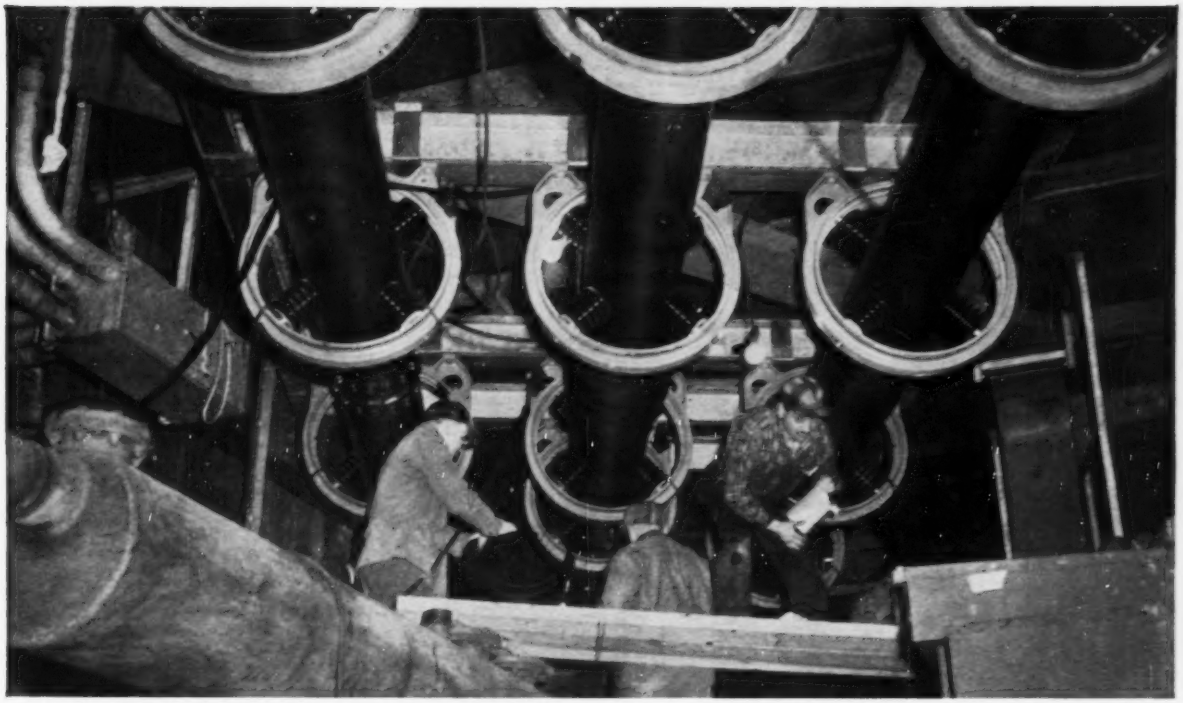
High Temperature Wire Markers. Teflon wire markers for high temperatures and high frequency application are now available from The E C P Corporation, 4726 Superior Ave., Cleveland 3, Ohio. Teflon is extruded from Du Pont tetrafluorethylene resin and converted into markers to identify circuits in complex wiring systems where resistance to heat and chemicals is a factor. The markers when exposed to temperatures up to 260 C or 500 F will not melt, flow, or disintegrate. The markers are nonflammable and resist damage, attack, and corrosion from all chemicals and solvents, except molten alkali metals and fluorine, at elevated temperatures and pressures. They are inert to all fungi growths. Literature, prices, and specific application information are available from the company.

"Straight Up" Boiler Feed Pump Ventilation. These motors take air from the floor level and discharge it straight up. Advantages are as follows: side by side boiler feed pump motors will not "trade" ventilating air, recirculation of ventilating air



is avoided, and the motors can be placed closer to each other, thereby taking up less floor space. They are available in ratings up to 4,000 hp at 3,600 rpm. For further information contact Electric Machinery Mfg. Company, 1331 Tyler St., N.E., Minneapolis 13, Minn.

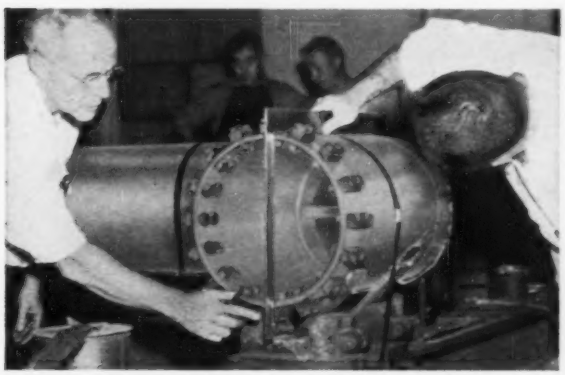
(Continued on page 52A)



Installing the self-cooled isolated phase bus structure to carry 6500 amps at 20 kv from the generator to the power transformers at Steam Turbo-Generator Unit #3 at the Astoria Station of the Consolidated Edison Co. The tubular copper bus, 13½" O.D., .406" wall thickness, is wrapped with black insulating tape prior to installation.

Big Tubular Copper Bus Carries 6500 amps at 20 kv

At its #3 Steam Turbo-Generator at Astoria, L. I., the Consolidated Edison Company uses these large Anaconda tubular copper conductors to carry generator output to the power transformer. These special conductors are another example of how Anaconda can help meet special conditions. Though well beyond the standard-pipe-size copper bus tube, they are by no means the largest. Anaconda can produce seamless copper tubes up to 26 inches, I.D.



13½" O.D. x .406" tubular bus being fabricated at R & I E Equipment Div. of I-T-E Circuit Breaker Co., Greensburg, Pa. Everdur® nuts are silver-alloy brazed inside the tube and the bolts withdrawn. Then in assembly at the site, the nuts are in place for fast, easy installation. A total of 1,128 feet of tubular bus was required.

In general, where mechanical requirements permit, bus costs can be cut through the use of tubular bus conductors with low wall-thickness-to-diameter ratios. The weight of metal purchased goes down as the t/d goes down. Round tubes in the standard pipe dimension, and thin-wall sizes, also offer other advantages. They make it possible for you to utilize the great variety of stock sizes of supports, connectors, clamps, and other line hardware.

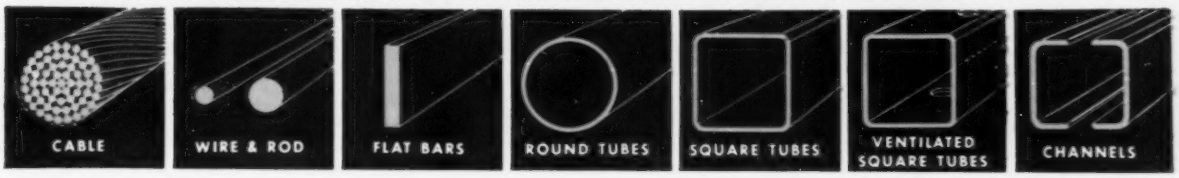
TECHNICAL SERVICES. Anaconda specialists are available to help you in the solution of technical problems involving the use of Anaconda Bus Conductors. For such service, or for a copy of Publication C-25, see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn.

ANACONDA®

COPPER CONDUCTORS

Made by The American Brass Company

THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED



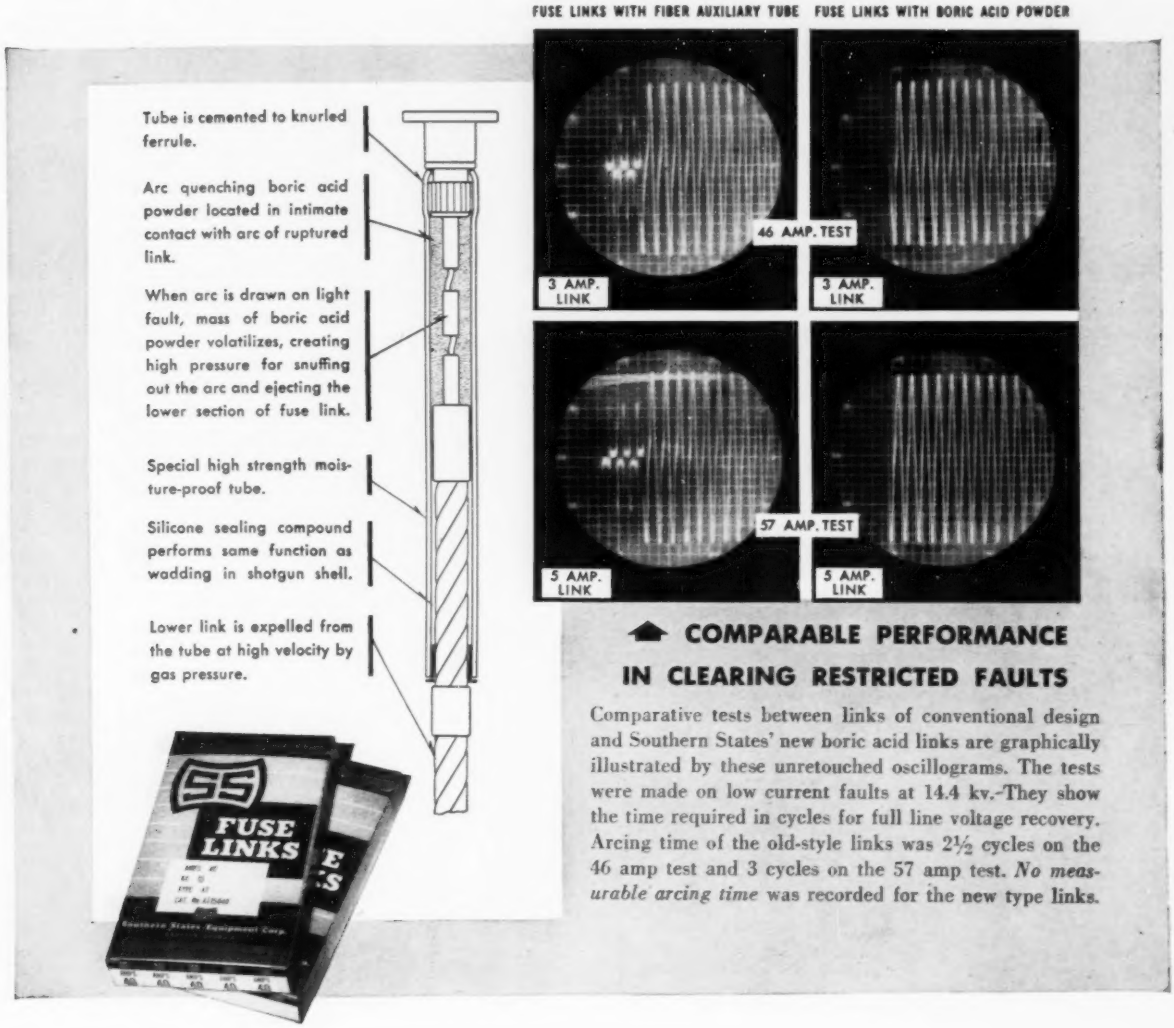
SOUTHERN STATES FUSE LINKS SOLVE PROBLEM OF LOW FAULTS

The problem of clearing restricted faults can be effectively eliminated by using Southern States boric acid fuse links. Even when using large bore cutouts, a low-magnitude fault can be cleared with little arcing.

As the illustration below shows, boric acid powder is in intimate contact with the fusible element. When the link ruptures, the mass of boric acid volatilizes, building a vapor pressure high enough to quench the arc instantly.

The added protection afforded by boric acid links virtually eliminates the possibility of cutout failure when called on to operate in the low current range.

Standard construction features of these links include: silver plating of all external metal parts . . . high-strength crimped joints . . . low-melting temperature elements . . . and moisture-resistant auxiliary tubes. You get a stronger link, more resistant to corrosion, and more dependable than ever.


Tube is cemented to knurled ferrule.
Arc quenching boric acid powder located in intimate contact with arc of ruptured link.
When arc is drawn on light fault, mass of boric acid powder volatilizes, creating high pressure for snuffing out the arc and ejecting the lower section of fuse link.
Special high strength moisture-proof tube.
Silicone sealing compound performs same function as wadding in shotgun shell.
Lower link is expelled from the tube at high velocity by gas pressure.
FUSE LINKS WITH FIBER AUXILIARY TUBE
FUSE LINKS WITH BORIC ACID POWDER
46 AMP. TEST
3 AMP. LINK
3 AMP. LINK
57 AMP. TEST
5 AMP. LINK
5 AMP. LINK
SS
FUSE LINKS

COMPARABLE PERFORMANCE IN CLEARING RESTRICTED FAULTS

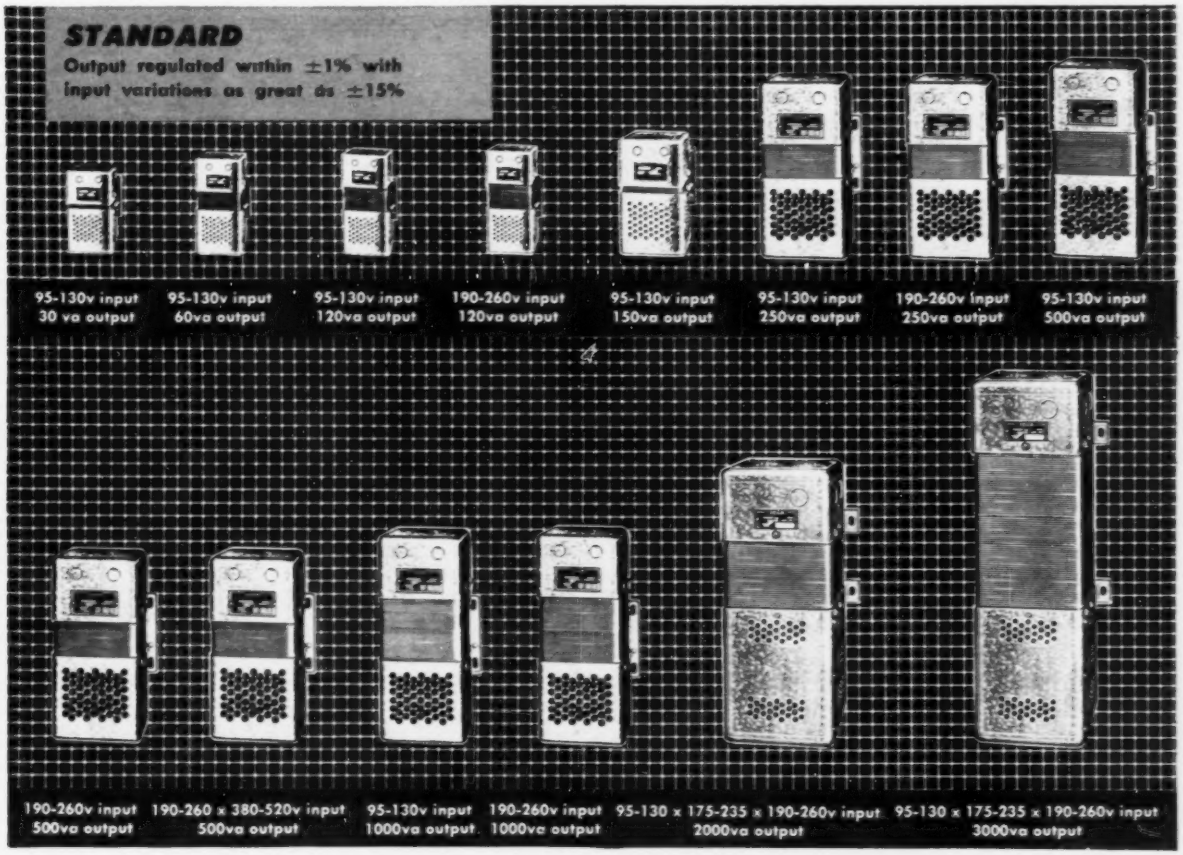
Comparative tests between links of conventional design and Southern States' new boric acid links are graphically illustrated by these unretouched oscillograms. The tests were made on low current faults at 14.4 kv. They show the time required in cycles for full line voltage recovery. Arcing time of the old-style links was 2½ cycles on the 46 amp test and 3 cycles on the 57 amp test. *No measurable arcing time* was recorded for the new type links.

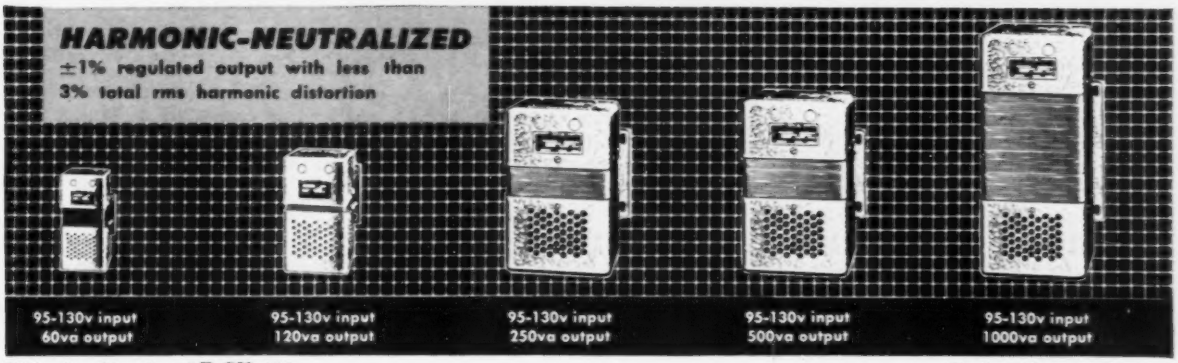
SOUTHERN STATES EQUIPMENT CORP.
HAMPTON, GEORGIA

IN CANADA: Dominion Cutout Co., Ltd., Toronto

New Sola Constant Voltage Transformers feature less size and weight; greater efficiency

Sola now has many improved designs in standard and harmonic-neutralized static-magnetic voltage regulators. These new designs — 19 in all — offer size reductions up to 60%, and weight reductions to 55%. Greater efficiency is achieved from improvements in core design. As with other Sola static-magnetic regulators, these new ratings provide output regulation of ±1%, with input voltage fluctuations up to ±15%. Response time is 1.5 cycles or less. There are no moving parts, no manual adjustments. These are but part of a full selection of 44 stock ratings from 15va to 10kva output capacity.


STANDARD
Output regulated within ±1% with input variations as great as ±15%
95-130v input 30 va output
95-130v input 60va output
95-130v input 120va output
190-260v input 120va output
95-130v input 150va output
95-130v input 250va output
190-260v input 250va output
95-130v input 500va output
190-260v input 500va output
190-260 x 380-520v input 500va output
95-130v input 1000va output
190-260v input 1000va output
95-130 x 175-235 x 190-260v input 2000va output
95-130 x 175-235 x 190-260v input 3000va output

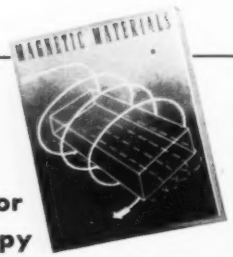

HARMONIC-NEUTRALIZED
±1% regulated output with less than 3% total rms harmonic distortion
95-130v input 60va output
95-130v input 120va output
95-130v input 250va output
95-130v input 500va output
95-130v input 1000va output

Write for Circular- 5F-CV-170. *Each grid equals 1 inch.*

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., BIshop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., Canmotor Ave., Toronto 14, Ont.

How to make a Magnetic Core that's really SMALL?

use AL PERMENDUR



Write for your copy "MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

ADDRESS DEPT. EL-6.

When the conditions of service make it imperative for you to hold the size and weight of magnetic cores at an absolute minimum, that's the place to use Permendur. With it you can push the flux density up to 20 kilogausses, and practically eliminate weight as a consideration.

Along with its suitability for cores wherever the premium is laid on compactness, Permendur is just the thing for sonar magnetostriction applications, too. We maintain proper annealing facilities for this alloy. Write for technical data on it, and let our engineers help you to cash in on its possibilities.

In addition to Permendur, we offer a range of high-permeability alloys, oriented silicon steels and other electrical alloys that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment.

Let us supply your requirements. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

STEELMAKERS to the Electrical Industry

Allegheny Ludlum

WSW 6119

AL STEELS FOR THE ELECTRONIC AGE

never before!

COMPACT, LOW-WEIGHT CONNECTORS WITH HIGH CURRENT RUPTURING RATINGS*

The new industrial series "C" Pyle-Star-Line connectors combine unique insulation and construction characteristics which make possible extraordinarily high circuit breaking ratings for the size and weight of the shell.

"Sandwich Insulation"—a resilient silicone insulation disc which floats between two rigid discs absorbs shock and vibration and permits the contacts to align themselves. The silicone, under pressure, reacts like a fluid. It flows into all crevices about the contact pins and sockets—positively prevents moisture or dust from passing through the insulation or accumulating to cause failures from short circuits or grounds.

Contact Inserts

Tough Anodic Coating of shell provides a smooth, attractive finish which has a hardness equal to 40 on the Rockwell C scale.

Rugged, Compact, Low-Weight Shell machined from high tensile strength aluminum...combined with the unique insulation features...provide a safe reliable, easy-to-handle connector which is highly resistant to the most punishing extremes of temperature, pressure, shock, vibration, corrosive dusts and moisture. Advantages never before combined in a single, standardized connector!

* **Listed by Underwriters' Laboratories** in circuit breaking ratings of 30, 60, 100 and 200 ampere, 600 volt, A.C.

Write for 64-page catalog, No. 1252-I

SINCE 1897

THE PYLE-NATIONAL COMPANY

WHERE QUALITY IS TRADITIONAL

1378 North Kostner Avenue, Chicago 51, Illinois

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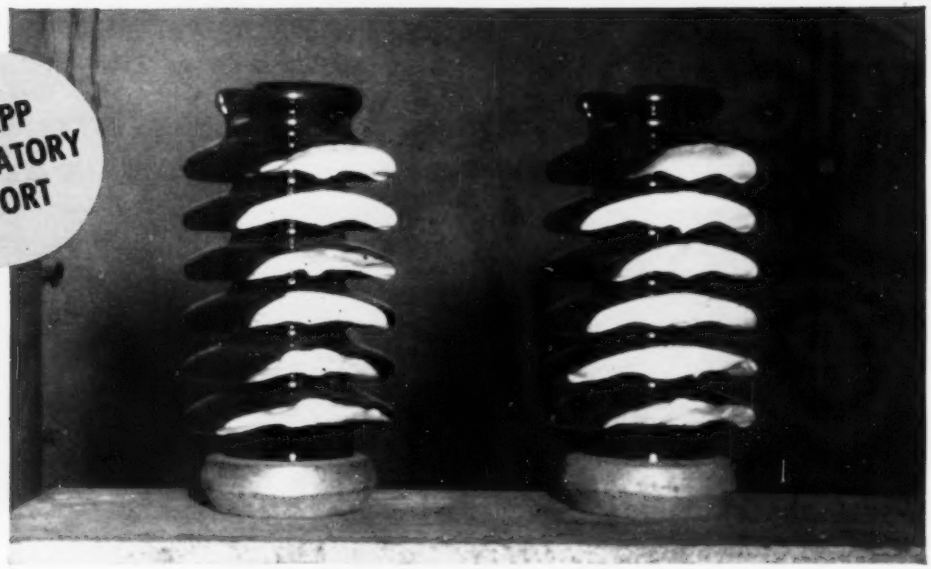
CONDUIT FITTINGS • PLUGS AND RECEPTACLES • LIGHTING FIXTURES • FLOODLIGHTS



BROKEN CORRUGATIONS... how do they affect performance?

THE PROBLEM: It is well known that mechanical damage to the Lapp Line Post insulator causes much less loss of its electrical characteristics than does such damage to pin-type or suspension insulators. Good maintenance on a system generally does call, however, for changing out insulators that show sign of damage. How urgent is it to replace insulators reported as being damaged? The answer, of course, involves security of the system as well as economy of maintenance, and can be found only in evaluation of characteristics.

THE TEST: Utility engineers whose company operates a large system on Lapp Line Posts wished to set a standard procedure for Line Post maintenance. They visited the Lapp plant and had us make laboratory tests of 35 kv Lapp Line Posts, measuring dry and wet flashover value with petticoats progressively broken off. (We used a hammer to simulate mechanical damage in the field.)

THE FINDING: With the top petticoat broken off, dry flashover was reduced less than 1%, wet flashover by slightly less than 4%. With all six petticoats gone (as shown in the photo) flashover tests showed a loss of 7% in both dry and wet 60-cycle flashover. (In a similar test made previously, we found loss of all corrugations reducing wet flashover somewhat more—apparently the exact pattern of the break has an important effect.)

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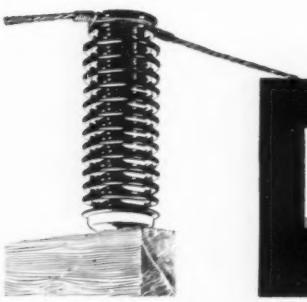


Lapp

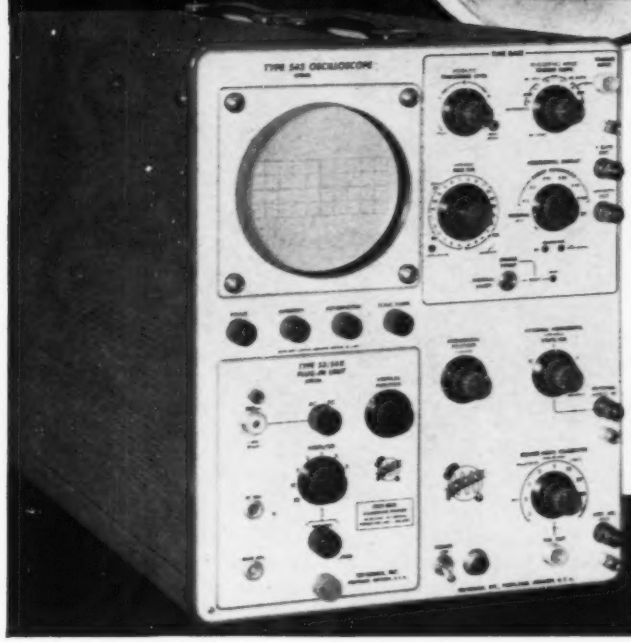
THE MORAL: Use Lapp Line Posts on your system for distribution and subtransmission up to 88 kv. They'll give you an extra margin of operating security, low maintenance cost and long life.

Lapp Insulator Co., Inc., LeRoy, N. Y.

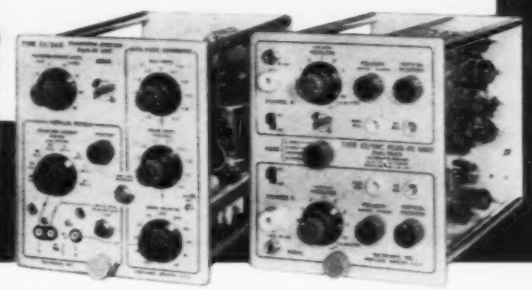
NEW PERFORMANCE FEATURES

NEW OPERATING CONVENIENCE

TYPE 543
DC-to-30 MC OSCILLOSCOPE



This new fast-rise oscilloscope with the Tektronix Plug-In Feature is extremely versatile and easy to operate. With a single Type 53/54 fast-rise plug-in preamplifier the Type 543 handles the usual applications in the DC-to-30 MC range. Many other inexpensive plug-in units are available for the more-specialized jobs, including one for transistor rise, fall, delay and storage time testing.



MAIN CHARACTERISTICS

VERSATILITY
Nine Available Plug-In Preamplifiers—Wide Band, Dual Trace, Low Level, Differential, and others for specialized applications.

HIGH PERFORMANCE
DC to 30 MC with fast-rise plug-in units.
DC to 24 MC with dual-trace plug-in unit.
0.02 μsec/cm to 15 sec/cm sweep range.

EASY OPERATION
24 Calibrated Direct-Reading Sweep Rates.
Sweep Magnification—2, 5, 10, 20, 50, and 100 Times.
Preset Triggering—Eliminates triggering adjustments in most applications.
Single Sweep Operation—Lockout-Reset Circuitry for one-shot recording.

HIGH WRITING RATE
250 cm/μsec. 10-kv accelerating potential assures bright trace for operation in single-sweep applications, and with low sweep repetition rates.

TYPE 543 PRICE, without plug-in units **$1200**
Type 53/54K Fast-Rise Unit **$125**
Type 53/54C Dual-Trace Unit **$275**
Type 53/54R Transistor Test Unit **$300**
Prices f.o.b. factory.

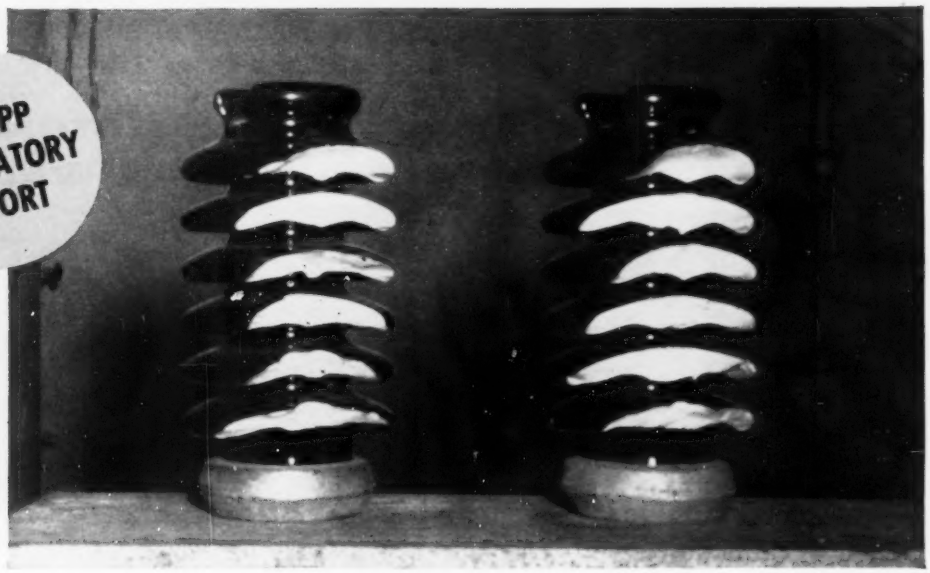
Please call your Tektronix Field Engineer or Representative for complete specifications and, if desired, to arrange for a demonstration at your convenience.

ADD SWEEP LOCKOUT *to your Tektronix Type 531 and 541 Oscilloscopes—order Modification Kit*
K531 Sweep Lockout, Tek. 040-118 ..... **$25**
for Type 532
K532 Sweep Lockout, Tek. 040-147 ..... **$25**

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

A LAPP LABORATORY REPORT



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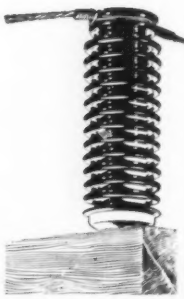

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Along today's modern highways easy-to-handle J-M Transite Ducts provide installation economies and years of service life, protecting traffic-signal, lighting, and other power-service circuits.

J-M Transite® Ducts install fast to last... give complete cable protection.

Because speed and economy set the pace in today's highway programs, more and more highway cables are going into Johns-Manville Transite Ducts.

For speed, Johns-Manville Transite Ducts are strong, light and long—easy to handle and install. Workmen set 10-foot lengths in place easily, join them up tight in seconds with snug-fitting J-M Plastic Couplings, and Transite's smooth bore is free of burrs and other obstructions that may interfere or cause damage during pulling of cables.

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Let us send you free Transite Duct brochure EL-29A. Write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

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Cast Alnico Magnets are most commonly made in Alnico V and VI. Sintered Alnico Magnets usually are made in Alnico II, V or VI. Special permanent magnet materials include Vicalloy, Cunife, and Arnox.

Engineering Data

Write for your copy of *Bulletin GC-106C*, a general catalog of all Arnold products. It contains useful data on the physical and magnetic properties of Alnico Magnets. Lists stock items and standard tolerances for cast and sintered magnets—also stock sizes and pertinent data on tape cores, powder cores, C & E cut cores, etc.

ADDRESS DEPT. EL-86

YOUR best bet when looking for a source of Alnico magnets and assemblies is Arnold—producer of the most complete line of magnetic materials in the industry.

Arnold can supply your need for any size or shape of Alnico magnet. Weights range from a few ounces to 75 pounds or more. Die-cast or sand-cast aluminum jackets, Celastic covers, etc., can be supplied as required. Complete assemblies are available with Permendur, steel or aluminum bases, inserts and keepers as specified—magnetized and stabilized according to the requirements of the application.

A wide range of the more popular shapes and sizes of cast and sintered magnets are carried in stock at Arnold. Unsurpassed plant facilities make possible quick delivery of all special orders. ● *Let us handle your permanent magnet requirements, or any other magnetic material specification you may have.*

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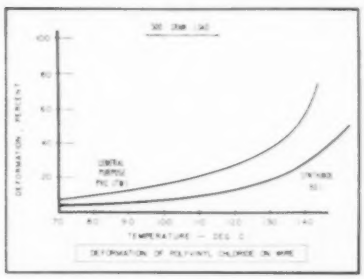
Troubled with wiring failures in your plant?

If so, consider the record being established by Rome Synthinol 901, a special 90° PVC compound for wire insulation and sheathing. It has helped to solve an impressive list of difficult wiring problems.

Developed by Rome Cable's laboratory and first introduced in 1949, Rome Synthinol 901 has proved by test and actual use to be superior to conventional PVC compounds in the following ways:

a. Suitable for continuous operation at higher temperature (90°C).
b. More stable under severe heat cycling.
c. Suitable for continuous immersion in hot transformer oil.
d. Superior resistance to chemicals and solvents.
e. Greater resistance to heat deformation.



Graph shows heat deformation vs. temperature, and compares Synthinol 901 with conventional PVC compounds. Test run in accordance with Underwriters' Laboratories standard procedure, except for temperature.

The practical value of this compound can best be illustrated by describing a number of actual case histories.

(1) Oil refinery, industrial and chemical plant wiring.

Plant and oil refinery engineers have long used conventional PVC insulations for plant wiring with good results, but too often heat deformation problems arose in warm locations. Since Rome Synthinol 901's superior deformation resistance suggested that it might be the answer to this problem, it was tried and soon became widely used because of its much better service record.

Synthinol 901 also proved to be far superior to conventional materials for chemical plant wiring where the corrosive action of chemicals and solvents has always been a tough problem. Although polyvinyl chlorides as a class have inherently better resistance to chemicals and solvents than many other materials, some engineers desired even further improvement. One user decided to test a number of samples over a long period by immersing them in various concentrations of acetone, different alkalis, and butyric, propionic, and acetic acids. The results of this careful evaluation showed clearly that, when exposed to these chemicals, Synthinol 901 would last longer than any other PVC tested.

(2) Oil-filled transformers.

Transformer engineers have long sought a cable construction to replace varnished cambric-insulated cable for leads in oil-filled transformers. These leads connect transformer windings and bushings and are constantly immersed in hot oil. One transformer manufacturer, encouraged by successful experience with Synthinol 901 on other applications, undertook a comprehensive study of the possible usefulness of this insulation in lieu of varnished cambric for high-voltage transformer leads. This study extended over a several-year period and proved to those engineers involved that there were at least four reasons for standardizing on Synthinol 901 for this application:

a. There was less sludge in the oil than when VC insulation was used.
b. There was no harmful degradation of the electrical properties of the oil.
c. Conductors insulated with Synthinol 901 ran cooler, permitting a 7% increase in lead cable current rating.
d. The use of Synthinol 901 in lieu of VC would permit substantial dollar savings.

(3) Coil leads.

Many manufacturers of small coils for relays, small transformers, small motors, and electronic components have tried to use PVC insulated lead wires for many years. Typically, these leads are crimped or soldered to the ends of the coil; and the whole coil is then impregnated with varnish or wax and baked as long as 16 hours at temperatures as high as 150° C. The varnish used may be asphaltic, phenolic, alkyd, etc.; and the wax may be paraffin, beeswax, carnauba, or another kind.

PVC insulated lead wires frequently produced serious production problems because of the insulation's tendency to shrink, crack, and stiffen during the impregnation and subsequent baking period. Synthinol 901 was substituted in place of the ordinary PVC insulation and, after nearly eight years of wide usage, not a single case of shrinkage, cracking, or stiffening of insulation involving Synthinol 901 has been brought to our attention.

These case histories describe just a few of the applications for which Rome's Synthinol 901 has proved especially effective. Perhaps they will suggest other applications in your own area which might also be better handled with Rome Synthinol 901 instead of a conventional PVC compound. If you have a wire or cable problem that might be solved with Rome Synthinol 901, why don't you get in touch with us? Contact your nearest Rome Cable representative for more information—or write to Department 322, Rome Cable Corporation, Rome, N. Y.

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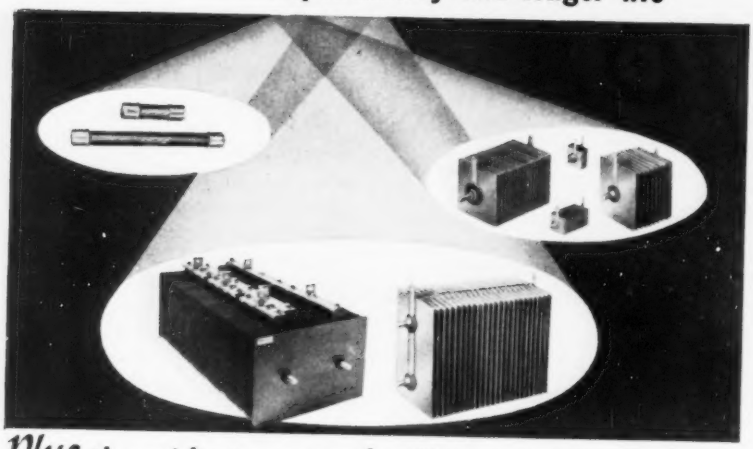

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SYNTRON builds rectifier stacks for every application — from Industrial Power Stacks with 12" x 16" cells, largest in the industry, down to low current, high voltage hermetically sealed cartridge type stacks.

SYNTRON Selenium Rectifiers provide high efficiency, low maintenance and longer life to every application.

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Our representatives will be glad to work with you in selecting the proper equipment for your operation.

Call your nearest Syntron representative

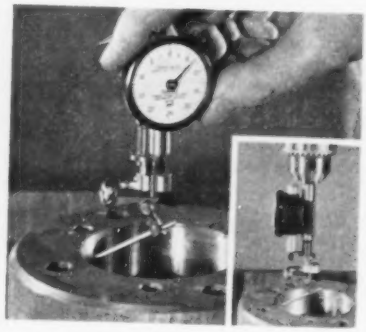
For more information write for complete catalog . . Free

SYNTRON COMPANY
440 Lexington Avenue **Homer City, Penna.**

New Products

(Continued from page 40A)

Center-Finder. The Schwieterman Center-Finder, manufactured by The Precision Gage and Tool Company, 320 E. Third St., Dayton 2, Ohio, insures the greatest possible accuracy in center finding with the least possible expenditure of time and



effort, thereby speeding production and increasing profits. The Center-Finder accurately locates the spindle of a jig boring machine, vertical or horizontal milling machine, boring mill drill press, or similar machines in the exact center of a hole, plug, or jig button for the purpose of reboring old holes, boring new holes in relation to old ones, or locating holes in new work using jig buttons or master plates.

"Golden" Corvette Copying Machine. A copying machine, the "Golden" Corvette, has been announced as a high-production, low-priced unit especially designed for small business firms and larger company department or branch office operations. The machine is automatic, electric plug-in, has an 11 inch copying width capacity, is a continuous feed type, and is said to be twice as fast as comparable models. It will reproduce anything from typing, printing, any ink color, ball point or fountain pen writing, from tissue thin paper, opaque bond, or sheets printed on one or both sides. The "Golden" Corvette is manufactured by the Cormac Photocopy Corporation, 80 Fifth Ave., New York 11, N.Y., and is nationally distributed through regional branch and sales offices of the company, and over 350 authorized office equipment dealers in the United States, Puerto Rico, Canada, Mexico, and other foreign countries.

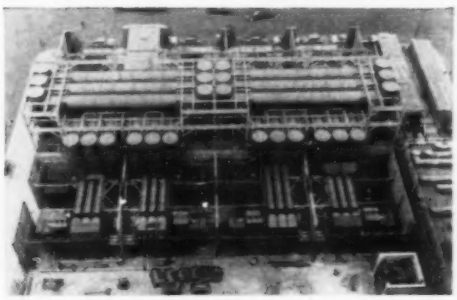
Aluminum Cable Trough. Cable trough is now offered in expanded aluminum to supplement the expanded galvanized steel cable supports from T. J. Cope Division Rome Cable Corporation. The new aluminum cable supporting system includes a wide range of standard fittings to provide simplicity, flexibility, and low cost in installation. Its light weight reduces installation costs. Aluminum also offers resistance to many corrosive atmospheres. Cable installation equipment is available from T. J. Cope Division Rome Cable Corporation, Collegeville, Pa.

(Continued on page 54A)

R&IE METAL-ENCLOSED SWITCHING STATIONS

R&IE 138 kv isolated phase bus installed at Consolidated Edison's East River Generating Station, New York City.

138 kv Isolated Phase Bus Saves Space for Midcity Switching Station



A tight fit. The compact design of the 138 kv switchyard at Con Edison's East River Station is graphically illustrated by this overhead view. R&IE 138 kv isolated phase bus occupies the upper level. To maintain complete phase isolation, the bus housings enclose the 138 kv bushings on the main transformers. R&IE 69 and 13.2 isolated phase bus are shown in the lower part of the photograph.

Load forecasts indicated that Con Edison's East River Generating Station in New York City would need support from the 138 kv tie system. Its location in a congested part of the city ruled out a space-consuming conventional switching station. But, with use of R&IE 138 kv isolated phase bus, the new station was built on a plot only 62 x 162 ft.—reducing by 30% the area needed.

R&IE Isolated Phase Bus can be used in relatively small spaces with complete safety to personnel and equipment. In addition, it assures better continuity of service and virtually eliminates the possibility of phase-to-phase faults. Its strong, weatherproof construction minimizes maintenance.

Disconnect and grounding switches, pothead cubicles, surge protection cubicles, and other similar station elements are available utilizing isolated phase construction. Ratings from 12 to 230 kv can be supplied. For full information, contact your nearby I-T-E sales office. Or write R&IE Equipment Division, Greensburg, Pa.

I-T-E CIRCUIT BREAKER COMPANY
R&IE EQUIPMENT DIVISION · Greensburg, Pa.

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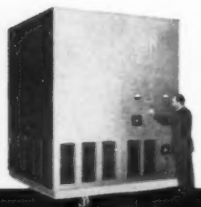

Of the thousands of Sel-Rex Rectifiers in use, a large percentage are "repeat orders"—units purchased only after an original installation had thoroughly proven itself.

Our users include the country's foremost electrical and electronic concerns* — companies best qualified to evaluate rectifier equipment.

**names on request*

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Rectifier Division

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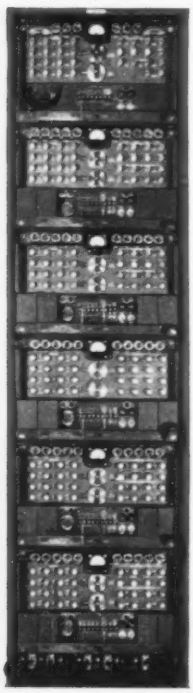

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FOUR OR 24 CHANNELS

Two miniaturized voice-multiplex systems providing four or 24 voice channels over radio or 4-wire cable are available. They have many advantages over earlier designs: high performance, small size, light weight, low cost, circuit simplicity, low power requirements, small number of tubes of a single type only, low operating cost, low maintenance and high reliability.

These systems provide a voice-channel flat within 1 db from 300 to 3500 cycles, for each 4 kc of bandwidth occupied. Each channel is equipped with hybrid, signalling, and dialling circuits for all the standard 2-wire and 4-wire loop options.

The basic unit provides an order-wire and 4 carrier-derived channels. These units can be stacked in groups of 2, 3, 4 or 5 by means of a group modem to provide 9, 14, 19 or 24 channels. Full flexibility is provided for dropping and inserting channel groups at repeater and terminal points. Moderate lengths of 4-wire cable or open-wire line may be inserted between the multiplex equipment and the radio terminals.

24-channel carrier-telephone terminal complete with hybrids, ringing and dialling circuits, and test facilities. Dimensions are 58" high, 16" wide and 8" deep. Power input 250 watts. Weight 326 lbs.

RADIO ENGINEERING PRODUCTS

1080 UNIVERSITY ST., MONTREAL 3, CANADA

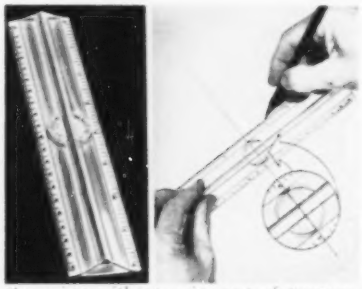
TELEPHONE
UNiversity 6-6887

CABLES
RADENPRO, MONTREAL

New Products

(Continued from page 52A)

Ruler Square. A new drawing instrument is announced by Kiva Products, Inc., 550 Hill Ave., Glen Ellyn, Ill., which permits the drawing of squares, rectangles, parallel lines, and exact right angle lines without use of triangle or T-square. Along the top edge of the ruler, running the complete length, is a transparent, plastic prism. In use, the ruler is placed across any drawn line or edge of a piece of paper. This line can be easily seen through the ruler. Now, if the line runs clean through



the prism without a jog out of trueness, the ruler is at right angles, all ready to draw your line at right angles. But if the original line jogs a bit as seen through the prism, that is, does not form a good clean, continuous line, without a break, then the ruler is not at right angles. In a matter of a second or so, the ruler may be turned one way or the other to make the true straight line required.

Multidesign Expanded Metal. Tool designs making possible the manufacture on a production basis hundreds of expanded metal patterns have been perfected. This is a departure from conventional diamond patterns. Some patterns make it possible to manufacture two or more characters or designs within a single pattern. These vary in appearance in openings from $\frac{1}{16}$ inch to as large as $1\frac{1}{2}$ inch and can vary in gage from 0.015 up to as heavy as 12 gage. This greater variety in design and types of metal makes it possible to offer large volume users of expanded metal an exclusive pattern for application to a particular product in a special industry. This is especially important to manufacturers who are proud of their product identification. For complete detailed information or for expert technical assistance, write Designers Metal Corporation, 448 E. 159th St., Harvey, Ill. Free literature is available.

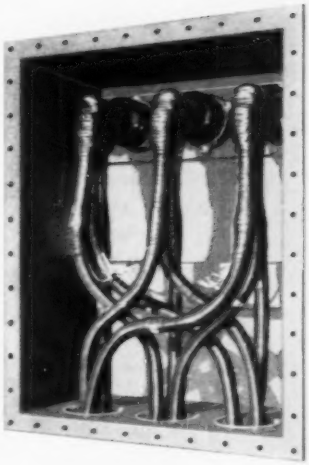
Gyro Transducer. A highly accurate gyro transducer for control of airborne vehicles or instrumentation telemetry systems has been developed by the Clary Dynamics Division of Clary Corporation. Consisting of three gyros mounted to sense motion about the roll, yaw, and pitch axes of a vehicle, the free gyros provide an accurate reference in the form of an electrical signal which is proportional to displacement about the outer gimbal axis. For further information, write for Brochure *CD-600*, Clary Dynamics, 408 Junipero St., San Gabriel, Calif.

750 MCM Single Conductor 91 Strands, 5KV Shielded SUPER-PARARITE PARAPRENE CABLE

PARANITE®

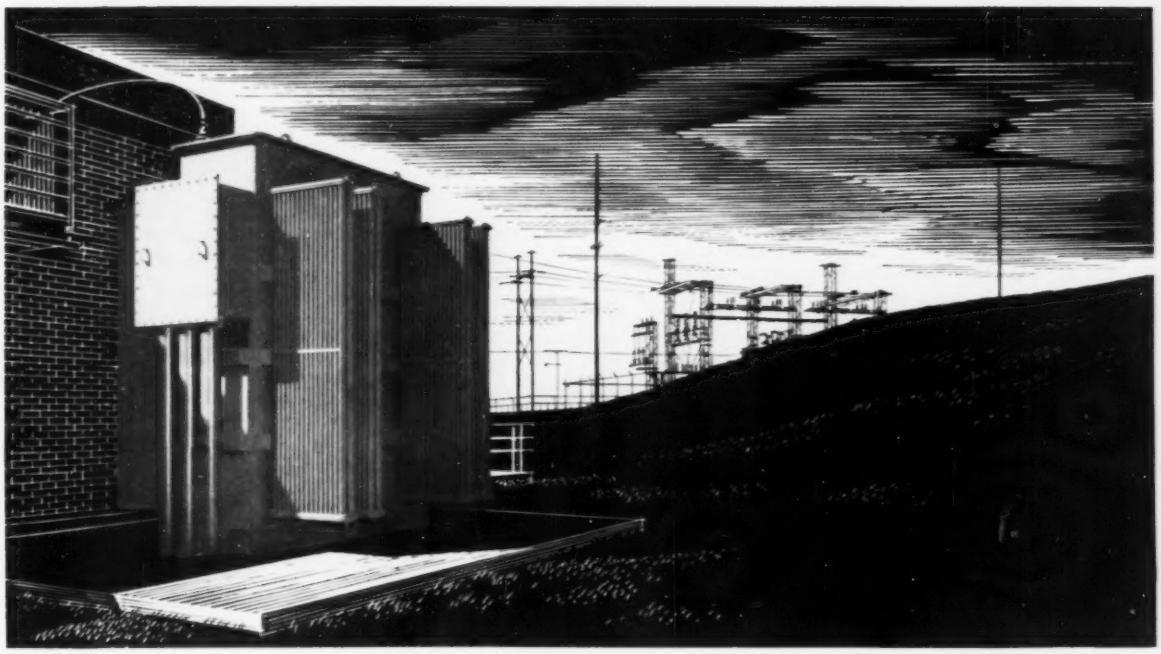
SUPER-PARARITE® PARAPRENE®

CABLE



Installed at Turkey Creek

Here's another example of power—Paranite—and American industry . . . the selection of Super-Pararite Paraprene Cable for the new Turkey Creek Pumping Station at Kansas City, Missouri. The Super-Pararite butyl conductor insulation is recognized for superior resistance to heat, cold, moisture, oxidation and ozone, while the Paraprene neoprene jacket possesses inherent resistance to sunlight, abrasion, ozone, heat, oil and chemicals . . . one of many Paranite products which has earned the industry reputation—"IF IT'S PARANITE IT'S RIGHT."®



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INDUSTRIAL NOTES

New Kodak Photo-Recording Paper. A photo-recording paper which is capable of providing an instantaneous visible record of instrumentation test data is now available. Designated as Kodak linagraph direct print paper, the new photo-recording material may be used in conjunction with several special-type moving-mirror galvanometer oscillographs. The paper should find wide application for immediate read-out of test results in the missiles and aircraft field, oil exploration, automotive, medical, nuclear, and many other control, production, and computing operations. Additional information on Kodak linagraph direct print paper and other photo-recording materials may be obtained from Graphic Reproduction Sales Division, Eastman Kodak Company, Rochester 4, N. Y.

New Kusko Facilities. Alexander Kusko, Inc., Consulting Engineers, have moved into new office and laboratory facilities at 141 Main St., Cambridge, Mass. The company carries out research and development work in electrical engineering, with emphasis on the application of magnetic and semiconductor devices to the control and processing of electric power. This includes work on magnetic amplifiers, transistors, electric machinery, rectifiers, electronics, and instrumentation. The president of the company is Dr. A. Kusko, associate professor of Electrical Engineering at Massachusetts Institute of Technology.

Clad Metals Addition. Silver-clad stainless steel is the newest addition to the clad metals line of American Silver Company, 36-07 Prince St., Flushing 54, N. Y. It is finding wide use as an efficient, inexpensive, and durable electrical contact material.

Navent. A tiny plastic seal, about the area of a thumbnail in size, helps assure the reliability of the powerful, liquid Rocketdyne rocket engines that have powered every major United States ballistic missile successfully launched to date. The tiny seal, trademarked "Navent," is a mushroom-shaped, nonmechanical valve which permits precision rocket engine assemblies to "breathe out" excess gases or escaping gases without sucking in contaminants. Propulsion engineers of Rocketdyne, a Division of North American Aviation, Inc., 6633 Canoga Ave., Canoga Park, Calif., invented the plastic mushroom valve during the development of powerful rocket engines for the Atlas, Thor, Jupiter, and Redstone missiles. Rocketdyne has licensed Navan Products, Inc., Santa Monica, Calif., to market the invention.

Plant Move. After more than 30 years in the Philadelphia suburb of Collingdale, Pa., the Shallcross Manufacturing Company is moving its entire operation to North Carolina. A new 41,000 square-foot plant is nearing completion in Selma, N. C., 28 miles south of Raleigh. Air-conditioned throughout, the new one-story plant will house expanded office, engineering, and manufacturing facilities. Separate departments will be maintained for the production of precision resistors, rotary switches, instruments, and attenuators.

Cold-Forged Jumbo Bolts. The complete cold-forging of large-diameter threaded fasteners doubles their fatigue life. Tensile strength is 12% better, and related static physical properties are also superior to those of bolts made by conventional production techniques. These are major findings of the first test study of static and dynamic properties of these big bolts. The completely cold-forged fasteners, hexagon head cap screws and bolts 7/8 inch through 1¼ inch in diameter and up to 10 inches long, are first products of the Cleveland Cap Screw Company's mammoth new 1½ inch Boltmaker, largest automatic machine of its type built—and said to be the only one in operation. Test findings are available on request from The Cleveland Cap Screw Company, 4414 Lee Rd., Cleveland 28, Ohio.

Human Electricity Literally Sets New Plant to Work. An electric current generated by the warmth of a human handshake literally turned on the power and put a new manufacturing facility to work recently. K. F. Julin, president of the Leach Corporation, Dominguez Estates, Rancho San Pedro, Compton, Calif., which produces and controls power for aircraft and missiles, held a small electric current producing device called a thermistor as he received a congratulatory open house handshake from Los Angeles Chamber of Commerce President G. B. Gose. The warmth of the handshake generated enough electricity in the thermistor to activate a system of sensitive Leach relays and set up a circuit that, amplified, turned on the new plant lights and started its machinery.

Dielectric Gas Development. Octafluorocyclobutane, the tongue-twisting name of a colorless, odorless, nonflammable gas composed of carbon and fluorine, may soon make possible more reliable, lighter weight electrical equipment, capable of handling higher voltages. Used as a dielectric, or insulating gas, it appears on the basis of research by leading electrical manufacturers to be a promising improvement over sulfur hexafluoride in high-voltage electrical equipment. Experimental quantities already are available, and E. I. du Pont de Nemours & Co. (Inc.) is prepared to go into commercial production when sufficient demand is evident. For further information contact F. R. Zumbro, 8531 Nemours Bldg., Wilmington, Del.

Sola. Ownership of Sola Electric Co., 1633 W. 16th St., Chicago, Ill., a manufacturer of precision electric and electronic components and products, has been acquired by Basic Products Corporation, Milwaukee, Wis. Sola Electric, a Division of Basic Products, will be operated by its present management.

(Continued on page 58A)

AIEE SPECIAL PUBLICATIONS

To meet a specialized need, or where it has become advantageous to collate a number of papers on a subject in one pamphlet, a series of special publications has been established. Prices quoted are (M) for AIEE members, and (N) for non-members.

		PRICE M	N
S74	AIEE Electric Heating Conference (4/55)	2.50	2.50
S16	Application of Electric Conversion Equipment to the Electrochemical Industry (11/47)	.40	.80
S9	Bibliography of Relay Literature, 1927-1939 (7/41)	.25	.50
S6	Bibliography on Automatic Stations, 1930-1941 (12/42)	.25	.50
S79	Bibliography on Corona and Gaseous Materials	1.50	1.50
S69	Bibliography on Electrical Safety (12/54)	.40	.40
S35	Bibliography on Electronic Power Converters (1/50)	.50	1.00
S97	Bibliography on Gaseous Dielectric Phenomena (4/57)	.75	.75
S62	Bibliography on High-Pressure Electric Arcs (5/54)	1.50	1.50
S68	Bibliography on Telemetering (12/54)	.50	.50
S87	Bibliography on Testing of Insulating Materials and Systems for Thermal Degradation (4/56)	.50	.50
S100	Bibliography on Watthour Meters (11/57)	3.00	3.00
S60	CIGRE Report on Corona Losses (7/52)	.75	.75
T98	Conference on Magnetic Amplifiers (8/57)	4.00	4.00
T91	Conference on Magnetism and Magnetic Materials (2/57)	7.50	7.50
T88	Conference on New Developments in Instrumentation for Industrial Control	3.50	3.50
S29	Cumulative Indexes to AIEE Transactions, 1911-1921 and 1922-1938	2.00	3.00
S29a	Cumulative Index to AIEE Transactions, 1939-1949	2.50	2.50
S90	Digital Computers for Power System Problems (3/57)	2.00	2.00
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T89	Electrical Engineering in the Rubber and Plastics Industries	3.50	3.50
S51	Electric Engineering Problems in the Rubber and Plastics Industries (1/53)	3.50	3.50
S58	Electrical Engineering Problems in the Rubber and Plastics Industries (10/53)	3.50	3.50
S67	Electrical Engineering Problems in the Rubber and Plastics Industries (4/54)	3.00	3.00
T99	Electrical Engineering Problems in the Rubber and Plastics Industries (8/57)	3.50	3.50
T72	Electrical Utilization of Aluminum Conference (3/55)	3.50	3.50
S23a	Electron Tube Survey of Instrument Manufacturers and Laboratories (3/48)	1.00	2.00
S50	Electronic Converter Applications and Tubes (7/52)	3.50	3.50
S25	Elements of Nucleonics for Engineers (3/49)	.60	1.20
S84	Index to United States Rectifier Patents (12/54)	1.00	1.00
S54	Joint AIEE/IRE Conference on Telemetering and Remote Control (4/53)	3.50	3.50
S94	Jointing, Splicing, and Terminating Copper & Aluminum Conductors (7/57)	2.25	2.25
S37	Lightning Reference Bibliography (4/50)	.35	.70
S28	Mathematics for Engineers	.15	.30
S65	National Telemetering Conference—1954	2.00	2.00
S57d	1953 AIEE Aircraft Technical Conference, Part II, Discussions (3/54)	.50	.50
S102	Performance and Protection of Aerial Cables (6/57)	2.50	2.50
S45	Power Supply for Resistance Welding Machines (4/52)	1.00	1.00
T70	Proceedings of the Eastern Joint Computer Conference (4/55)	3.00	3.00
T92	Proceedings of the Eastern Joint Computer Conference (5/57)	3.00	3.00
T85	Proceedings of the Western Joint Computer Conference	3.00	3.00
T93	Rectifiers in Industry (5/57)	4.00	4.00
S44	Review of Electronic Digital Computers (2/52)	3.50	3.50
S53	Review of Input and Output Equipment Used in Computing Systems (3/53)	4.00	4.00
S42	Sources of Electrical Energy (1/51)	.75	1.50
S36	Symposium on Electrical Properties of Semiconductors and the Transistor (1/50)	.25	.50
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S61	Thermal Evaluation of Insulating Materials (6/54)	1.50	1.50
S63	The 2nd Feedback Control Systems Conference (4/54)	3.50	3.50
T96	Third Biennial AIEE Conference on Electric Heating (4/57)	2.50	2.50
T76	Western Joint Computer Conference (3/55)	3.00	3.00

*An AIEE Conference Report, consisting of the full texts of the papers and discussions presented at a special AIEE technical conference on the subject.

Also available is the following publication, issued by EJC (Engineers Joint Council) of which AIEE is a member:

S13	Engineering Profession in Transition (1947)	.50	1.00

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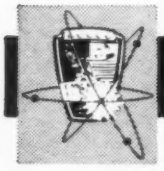

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Industrial Notes

(Continued from page 56A)

High-Density Polyethylene Production. A fully automated plant for making Bakelite high-density, low pressure, polyethylene is now in commercial production. At this plant, located in Institute, W. Va., production based on Ziegler-type catalysis will be at an annual rate of 30 million pounds. R. K. Turner president of Bakelite Company, Division of Union Carbide Corporation, 655 Madison Ave., New York 21, N. Y., said that these latest high-density polyethylene materials possess a unique combination of properties which will create many new plastics markets. They will also command a share of present plastics markets.

Cine-Radiography. Available for use by development engineers is Rototest's Cine-Radiographic Facility. A number of projects already undertaken for military prime contractors and subcontractors have resulted in immediate solutions of sticky problems, some of which previously had been considered unsolvable. The facility enables the engineer to analyze the internal operations of his sealed package while being subjected to environments such as vibration. An hour's study by X-ray motion pictures can replace many weeks of failure analysis attempted by other means. For further information contact Rototest Laboratories, Inc., 2803 Los Flores Blvd., Lynwood, Calif.

Alretic. A new concept in aluminum substations, which is expected to achieve substantial savings in engineering, field assembly time, and maintenance, is based on the use of standard prefabricated aluminum components. Known as Alrectic, the new substation erection method was developed by Handley-Brown Company, Jackson, Mich., with design and engineering assistance from Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11, Ill.

Westinghouse Semiconductor Plant. A manufacturing plant to keep pace with the rapidly changing semiconductor industry was recently put in operation by the Westinghouse Electric Corporation, Box 2278, Pittsburgh, Pa. The plant, near Youngwood, Pa., 35 miles southeast of Pittsburgh, is the result of the company's decision to enter the field of semiconductor devices primarily for power applications.

Alumoweld. As the result of a long period of intensive research and development work in conjunction with Battelle Memorial Institute, a new product to be known as Alumoweld, an aluminum-covered steel rod which can be redrawn into wire, may become an important new product of the company's Wire and Cable Division. This product will lend itself to many applications in the large markets where aluminum-type conductors predominate and will be of significant interest to many of the present users of copper-covered steel wire and strand. For further information contact Copperweld Steel Company, Frick Building, Pittsburgh 19, Pa.

TRADE LITERATURE

Portable Electric Plant Folder. How one man, with an Onan Portable Electric Plant, can do the work of a crew is explained and illustrated in a recently released folder. The convenience in portability plus the advantage in having a capacity for operating two hedge shears or grass clippers at one time, with power to spare, is explained as one of the factors for this plant being so adaptable for work in cemeteries, parks, and large estates. In addition, the versatile Onan units provide adequate electric power for concrete vibrators, electric saws, drills, and other equipment, as well as area floodlighting. Copies may be obtained by writing D. W. Onan & Sons Inc., 2515 University Ave., S.E., Minneapolis 14, Minn. and requesting folder *F-103*.

Mobile, Airborne Magnetic Tape Recorder. This 16-page brochure on the Ampex *800* mobile and airborne magnetic tape recorder gives complete recorder data such as: weight 100 to 150 pounds; easily withstands shock, vibration, and environmental variations encountered in mobile use; and accuracy and scope of data-recording capabilities comparable to large high-quality laboratory-type tape recorders. Complete equipment description, detailed specifications, photos of typical applications, and a tabular presentation of the various data requirements served are given in the brochure available from Ampex Corporation, 934 Charter St., Redwood City, Calif.

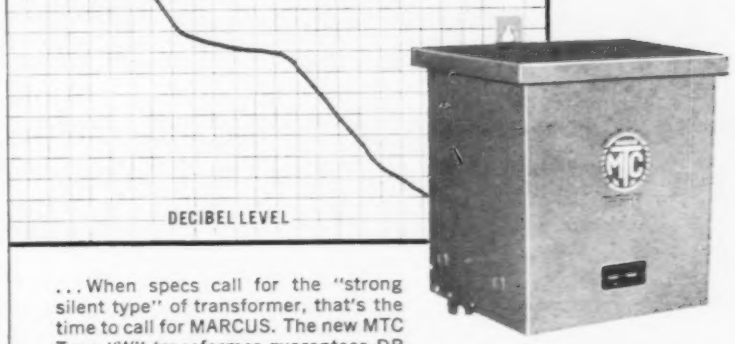
Price and Product Catalog. Electrical insulating materials for repair and maintenance shops are described in this 32-page price and product catalog. Issued every six months, catalog *23* contains descriptions, photos, prices, and ordering data. A good reference volume for electric service shops and industrial maintenance departments. Free copies of this catalog may be obtained by writing: Advertising Department, Insulation Manufacturers Corporation, 565 W. Washington Blvd., Chicago 6, Ill.

Resistance-Weld Pipe Mill Bulletin. Canada's all-electronically controlled Alberta-Phoenix Tube and Pipe, Ltd., resistance-weld pipe mill is discussed in a 4-page bulletin *L-2505*, published by Reliance Electric and Engineering Company, Cleveland, Ohio, and Toronto, Ont., Canada. Photos and drawings illustrate the extensive use of V★S drives in making the new mill so automatic that one man can operate the entire line, once setup is accomplished. Copies of Bulletin *L-2505* may be had free by writing to Reliance Electric and Engineering Company, 24701 Euclid Ave., Cleveland 17, Ohio.

Brake and Clutch Bulletins. Two informative folders on electric brakes and clutches have been made available by Warner Electrical Brake and Clutch Co., Beloit, Wis. Write to the company for either or both copies.

(Continued on page 62A)

QUIET POWER



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PERFORMANCE AND PROTECTION OF AERIAL CABLES

February 1958

This informative 44-page publication consists of six transactions and conference papers with discussions and closures on cable insulations, various practices in the installation of these cables, and the results of actual field tests to determine some of the phenomena which have taken place.

The papers were presented at the 1957 Summer General Meeting of the American Institute of Electrical Engineers, Montreal, Que., Canada, June 24-28, 1957.

Publication S-102 is available for $2.50 from the Order Department.

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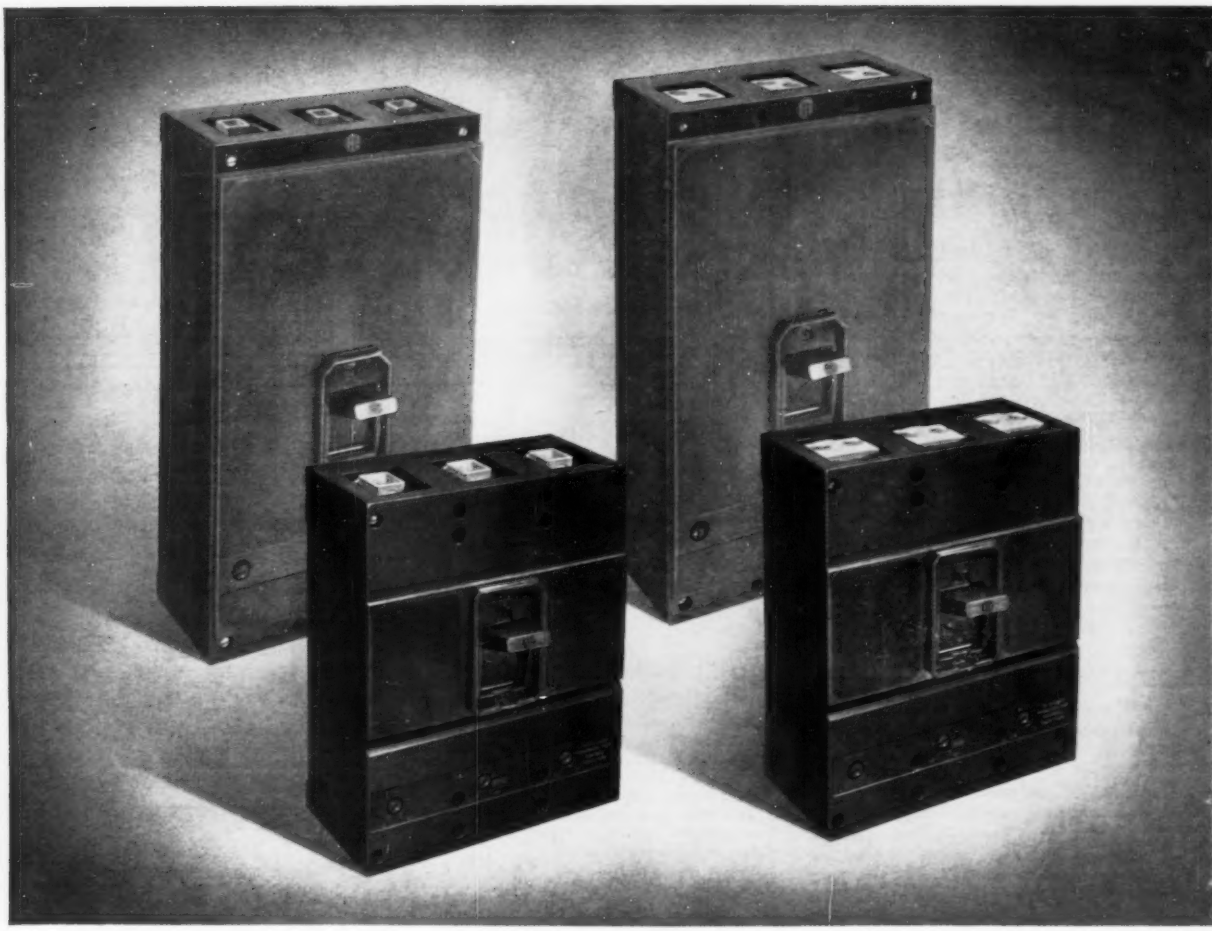

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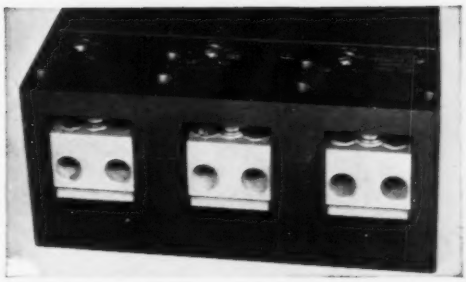

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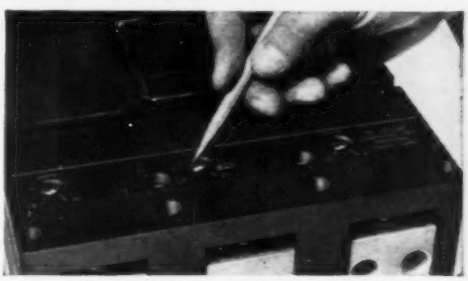

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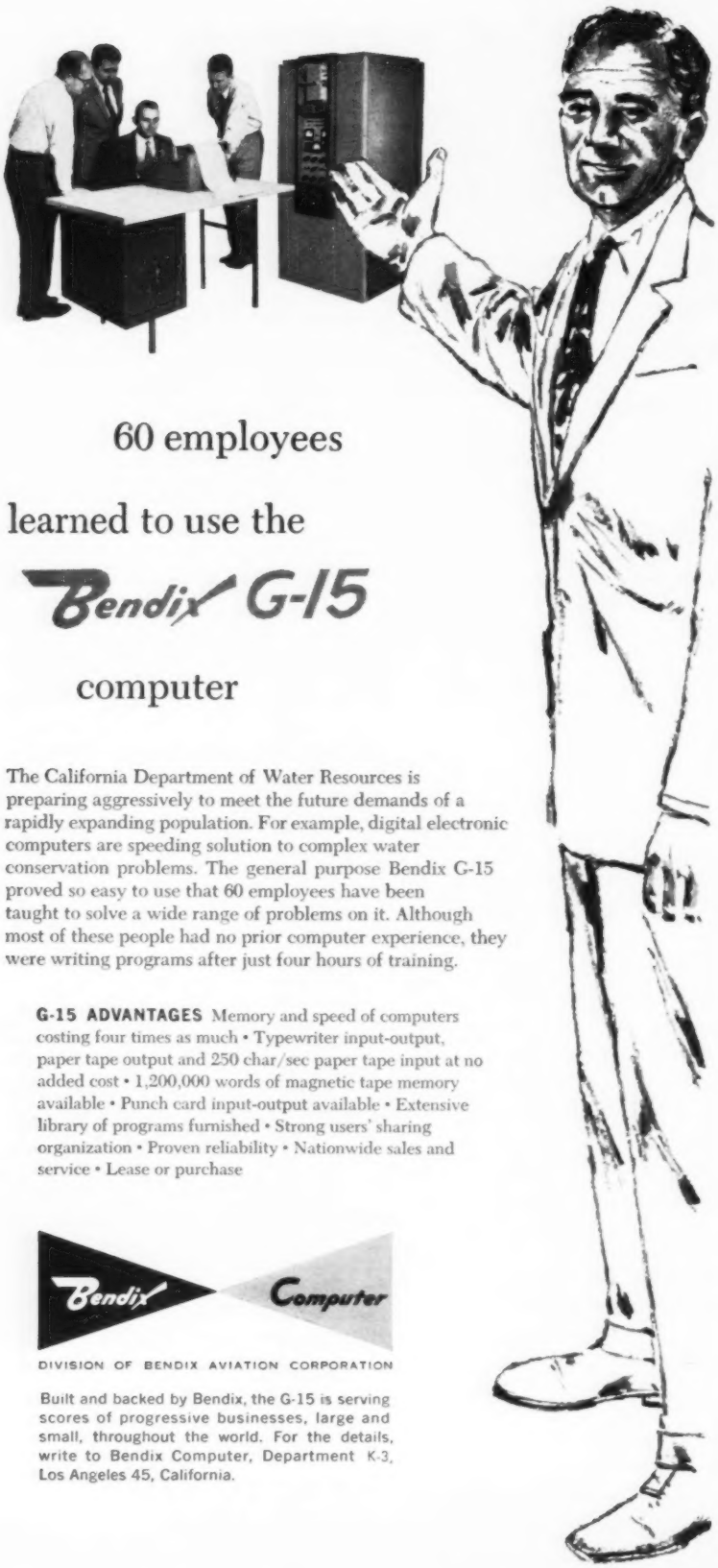

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Trade Literature

(Continued from page 59A)

Extruded Plastics Bulletin. A 12-page, 1958 edition of "Extruded Plastics" has been published. The illustrated brochure includes the latest information on complex shapes, rods, tubes, and moldings. It describes fabricated parts, discusses thermoplastic materials suitable for extrusion, and gives material property tables. The application of extruded parts in several industrial and consumer products is also shown. For a complimentary copy, write on business letterhead to Anchor Plastics Company, Inc., 36-36 36th St., Long Island City 6, N. Y.

Nuclear Engineering Services Brochure. A 4-page illustrated folder describing the nuclear engineering services of Burns and Roe, Inc., is now available. It describes this engineering and construction firm's work in nuclear power generation and reactor facilities, environmental testing, aviation test facilities, as well as materials manufacturing, processing, and handling. For a free copy of this folder, write to Publications Service, Burns and Roe, Inc., 160 W. Broadway, New York 13, N. Y.

Polytechnic Research. This 14-page booklet has been published by Comstock & Wescott, Inc., 179 Fifth St., Cambridge, Mass. The brochure gives information about the company and the experience of the staff. It outlines typical projects that have been tackled by the company.

Computer Bulletin Available. Available from Bendix Computer Division, 5630 Arbor Vitae St., Los Angeles, Calif., is an illustrated bulletin on the Bendix *G-15* general purpose digital computer. Featured is a full description of the simplified programming of this low-cost machine, which places it among the easiest computers to use. Engineers can be taught coding techniques within 2 to 4 hours. Specifications, accessory equipment, and applications are also described in the bulletin. Copies will be mailed on request.

Self-Locking Socket Screws. Socket screws, made selflocking by means of a nylon pellet inserted in the threaded section, are described and illustrated in a 3-color bulletin. The bulletin and prices of the products it describes may be obtained by writing to The Cleveland Cap Screw Company, 4444 Lee Rd., Cleveland 28, Ohio.

"Any-Speed" Drive Bulletin. A 32-page illustrated bulletin *10600* on Oilgear "Any-Speed" drives has been released by The Oilgear Company, 1570E W. Pierce St., Milwaukee 4, Wis. The bulletin explains the advantages, operation and characteristics of the company's Any-Speed drives and illustrates them with typical performance curves and block diagrams on different types of rotary applications.

(Continued on page 64A)

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62% Conductivity

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- U.R.C. (DBWP, TBWP) Copper
- Copperweld® Conductors
- Copper and Aluminum Building Wire
- ACSR and All Aluminum Cable
- Galvanized Steel Guy Strand and Static Wire
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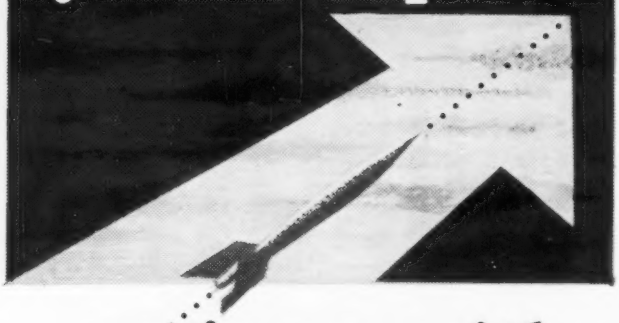

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Trade Literature

(Continued from page 62A)

Electrical Industry Brochure. "Anodized Aluminum Strip Conductor" is the title of the latest in a series of brochures published for the electrical industry by Reynolds Metals Company. The illustrated, 12-page booklet contains detailed technical information on the advantages, applications, heat transfer properties, winding, and joining of anodized aluminum strip conductors. Featured is a computation chart for obtaining strip conductor equivalents of wire gages and other data useful in coil design. The brochure also describes the company's engineering, laboratory, and field services, which are available to electrical manufacturers. Copies can be obtained by letterhead request to Reynolds Metals Company, 2500 S. Third St., Louisville, Ky.

Nuclear Magnetic Resonance Reprint. Now available from Schlumberger Well Surveying Corporation, P.O. Box 550, Ridgefield, Conn., manufacturers of the Model *104* NMR Analyzer, is an illustrated 12-page reprint of the technical article, "Nuclear Magnetic Resonance Supplies Fast Answers about Product Composition." The article covers basic NMR theory, operation of a typical NMR apparatus, research applications of NMR analysis, and use of NMR analysis in industry. Copies of the reprint are available free of charge from the company.

Miniature Ball Bearings Catalog. The 1958 version of a 24-page bulletin describing miniature ball bearings is now available from Miniature Precision Bearings, Inc., Precision Park, Keene, N.H. The new bulletin describes in detail the company's full line of miniature ball bearings which range in size from 3/8 of an inch outside diameter down to 1/10 of an inch outside diameter. Copies may be obtained by writing to the company.

Refractory Metals Journal. Published by Fansteel is a 4-page journal of information on the refractory metals, tungsten, molybdenum, tantalum, and columbium. Contact Fansteel Metallurgical Corporation, Metals & Fabrication Division, North Chicago, Ill.

Single-Phase Power and Lighting Transformers. New improvements in the Hevi Duty line of single-phase power and lighting transformers have been announced. This line has 28 standard sizes of transformers from 50 volt-amperes to 500 kva. The transformers have dual primary and dual secondary windings, and can also be used for 240-volt, 3-wire services. Sound levels are low enough for indoor installations. These transformers are also designed for optimum copper-to-core loss ratio. High-grade nonaging silicon steel assures low operating costs. For capacities, dimensions, weights, and prices send for Bulletin *100A* to Hevi Duty Electric Company, 4210 Highland Ave., Milwaukee 1, Wis.

(Continued on page 70A)

INERTIAL GUIDANCE ENGINEER John V. Prikazsky tells why airborne computer development at IBM Owego, N. Y., offers him the creative engineering career he always wanted.

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AIEE STANDARDS

Standards on electrical machinery and apparatus chiefly devoted to defining terms, conditions, and limits which characterize behavior, with special reference acceptance tests.

A discount of 50% is allowed to Institute members except as noted. College and bona fide public reference libraries are allowed (except in special cases with † below) a discount of 50% for nonmember prices, dealers and subscription agencies 20%.

1	General Principles Upon Which Temperature Limits are Based in the Rating of Electric Equipment (June 1957)	$0.80
1A	General Principles for Rating of Electric Apparatus for Short-Time Intermittent or Varying Duty (Sept. 1941) (A proposed supplement to No. 1)	—
1B	Guiding Principles for Specification of Service Conditions in Electrical Standards (May 1944)	.40
1D	Guide for the Preparation of Test Procedures for the Thermal Evaluation of Electrical Insulating Materials (June 1957)	—
1E	Guide for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electric Equipment (June 1957)	—
3	Guiding Principles for Selection of Reference Values for Electrical Standards (Oct. 1943)	.60
*4	Measurement of Voltage in Dielectric Tests (Sept. 1953) (ASA C68.1)	.80
*11	Rotating Electric Machinery Forming a Part of the Power Equipment on Electrically-Propelled Railway Cars, Locomotives, and Coaches (Trolley and Prime Mover) (Oct. 1957) (ASA C35.1)	.60
*16	Electric Control Apparatus for Land Transportation Vehicles (Oct. 1955) (ASA C48.1)	.60
*17†	Mathematical Symbols (Jan. 1928) (ASA Z10†)	.40
*18	Capacitor Units (Dec. 1951) (ASA C55.1)	.40
22	Air Switches, Insulator Units and Bus Supports (July 1952)	.80
25	Fuses Above 600 Volts (Feb. 1958)	.80
*28	Lightning Arresters for A-C Power Circuits (Jan. 1957) (ASA C62.1)	.60
*29	Wet Tests (July 1943) (ASA C77.1)	.40
31	Outdoor Coupling Capacitors and Capacitance Potential Devices (Jan. 1944)	.60
32	Neutral Grounding Devices (May 1947)	.80
43	Recommended Practice for Testing Insulation Resistance of Rotating Machinery (April 1950)	.60
48	Potheads (Jan. 1948)	.60
49	Roof, Floor, and Wall Bushings (Jan. 1948)	.60
50	Automatic Circuit Reclosers for A-C Distribution Systems (Jan. 1953)	.60
51	Guiding Principles for Dielectric Tests (6-55)	.60
54	Standard, Test Code, and Recommended Practice for Induction and Dielectric Heating Equipment (Sept. 1955)	.80
55	Guide for Temperature Correlation in the Connection of Insulated Wire & Cables to Electric Equipment (Jan. 1953)	.60
56	Guide for Insulation Maintenance for Large A-C Rotating Machinery (Feb. 1958)	.60
62	Guide for Making Dielectric Measurements in the Field (Apr. 1958)	1.00
74	Test Code for Industrial Control (600 Volts or Less) (Feb. 1958)	.80
425	Test Code for Transistors (Aug. 1957)	1.20
501	Test Code for Direct-Current Machines (7-57)	.60
502	Test Procedure for Single-Phase Induction Motors (Mar. 1958)	.60
503	Test Code for Synchronous Machines (June 1945)	1.40
510	Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery (Nov. 1956)	.80
550	Master Test Code for Resistance Measurement (May 1949)	.80
551	Master Test Code for Temperature Measurement (Aug. 1950)	.80
552	Master Test Code for Electrical Measurements in Power Circuits (Nov. 1955)	1.20
600	Specification for Speed Governing of Steam Turbines for Generators (500 kw and Up) (5-49)	.60
{601}{602}	Preferred Standards and Standard Specification Data for Generators for Large 3,600-rpm, 3-Phase, 60-Cycle Condensing Steam Turbine Generators (Jan. 1953)	.60
605	Specification for Speed-Governing of Hydraulic Turbines for Driving Generators (Sept. 1950)	.60
700	Aircraft D-C Apparatus Voltage Ratings (Oct. 1953)	.40
800	Test Code for Direct-Current Aircraft Machines (Jan. 1953)	.80
801	Test Code for Aircraft Circuit Interrupting Devices (July 1954)	.40
**950	Recommended Practice for Measurement of Field Intensity Above 300 Megacycles from Radio-Frequency Industrial, Scientific, and Medical Equipments (Apr. 1952)	.80
**951	Recommended Practice for Minimization of Interference from Radio-Frequency Heating Equipment (May 1950)	.80
**952	Electric Power Distribution for Industrial Plants (Oct. 1956)	3.50
**953	Grounding of Industrial Power Systems (10-56)	1.20
C8.1	Definitions and General Standards for Wire and Cable (Dec. 1944/Oct. 1953) (AIEE 30)	.40
C8.18	Specifications for Weather-Resistant (weatherproof) Wire and Cable (URC Type) (Jan. 1948)	.60
C8.19	Weather-Resistant Saturants & Finishes for Aerial Rubber-Insulated Wire & Cable (Nov. 1939)	.40
C29.1	Insulator Tests (Sept. 1944) (AIEE 41)	.80
C34.1	Pool Cathode Mercury-Arc Power Converters (Jan. 1949)	1.20
C37.1	Relays Associated with Electric Power Apparatus (Mar. 1950)	.60
C37.2	Automatic Station Control, Supervisory & Associated Telemetering Equipment (Oct. 1956)	1.30
C37.4	Alternating-Current Power Circuit Breakers (Dec. 1953)	.60
C37.5	Methods for Determining the Rms Value of a Sinusoidal Current Wave and a Normal Frequency Recovery Voltage & for Simplified Calculation of Fault Current (Dec. 1953)	.60
C37.6	Schedules of Preferred Ratings for Power Circuit Breakers (Sept. 1957)	.40
C37.7	Interrupting Rating Factors for Reclosing Service (Aug. 1952)	.30
C37.8	Rated Control Voltages and Their Ranges (8-52)	.30
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C37.14	Test Code for Low-Voltage Air Circuit Breakers (Aug. 1954)	.50
C37.15	Rated Control Voltages & Their Ranges for Low-Voltage Air Circuit Breakers (Aug. 1954)	.30
C37.16	Schedule of Preferred Ratings for Alternating- and Direct-Current Low-Voltage Air Circuit Breakers (10-56)	.30
C37.17	Preferred Pick-Up Calibrations and Trip Delay Settings for Alternating-Current Low-Voltage Air Circuit Breakers (10-56)	.30
C37.20	Switchgear Assemblies and Metal-Enclosed Bus (AIEE No. 27) (Jan. 1955)	.60
C39.1	Electric Indicating Instruments (Panel, Switchboard and Portable Instruments) (Aug. 1955)	2.00
C39.2	Direct-Acting Electric Recording Instruments (Apr. 1953)	.75†

* Approved as American Standard.
** A publication approved by the Standards Committee but not as a Standard.

C42 series	*American Standard Definitions of Electrical Terms*	
C42.10	Rotating Machinery (May 1957)	1.20
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C57.28	Test Code for Rectifier-Transformer Equipment (May 1948)	.30
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C57.34	Guide for Loading Pole-Type Constant-Current Transformers (May 1948)	.30
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C57.92	Guide for Loading Oil-Immersed Distribution and Power Transformers (Appendix to C57.12) (Jan. 1956)	1.25
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Z24.7	Test Code for Apparatus Noise Measurement (Dec. 1950)	.50
Z32.13	Abbreviations for Use on Drawings (Oct. 1950)	1.00
	Non-member total	$91.05
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AIEE REPORTS

These publications are proposals for new standards or test codes, or revisions of present publications, which are in the formative stage. They are made available **without cost**, so that all interested individuals may obtain them for study and comment, thereby supplying practical experience in their use before submission for adoption.

1A General Principles for Rating of Electric Apparatus for Short-Time Intermittent or Varying Duty (September 1941)
1D Guide for the Preparation of Test Procedures for the Thermal Evaluation of Electrical Insulating Materials (June 1957)
1E Guide for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electric Equipment (June 1957)
52 Application Guide for Grounding of Instrument Transformer Secondary Circuits and Cases (March 1951)
57 Test Procedure for Evaluation of the Thermal Stability of Enamelled Wire (October 1955)
58 Induction Motor Letter Symbols (January 1956)
59 Test Code for Metallic Rectifiers (March 1956)
64 Guide for Maintenance of Insulating Oil (November 1956)
65 Test Procedure for Thermal Evaluation of Ventilated Dry-Type Power and Distribution Transformers (November 1956)
66 Guide for Determination of Short-Circuit Characteristics of Direct-Current Machinery (July 1957)
67 Guide for Operation and Maintenance of Turbine-Generators (July 1957)
68 Device Numbers and Functions for Pipeline Pump Stations Under Automatic or Remote Control (Feb. 1958) (Proposed supplement to C37.2)
75 Test Code for Power-Factor Testing of Mineral-Oil-Insulated Instrument Transformers (Apr. 1958)
426 Graphical Symbols for Semiconductor Devices (Apr. 1958)
430 Recommended Practice for Toroidal Magnetic Tape Wound Cores (Apr. 1958)
431 Presenting Data on Magnetic Amplifier Core Materials (Apr. 1958)
450 Guide for Specification of Electronic Voltmeters (April 1955)
451 Guide for Specification of Signal Sources (April 1955)
452 Guide for Specification of Cathode-Ray Instruments (April 1955)
505 Test Code for Power Factor Testing of Power Transformers (January 1955)
506 Test Code for Power Factor Testing of Distribution Transformers (October 1955)
511 Test Procedure for Evaluation of Systems of Insulating Materials for Electric Machinery Employing Form-Wound Pre-Insulated Coils (October 1956)
802 Test Code for Direct-Current Carbon-Pile Voltage Regulators for Aircraft (April 1955)
803 Test Code for Aircraft Equipment Electrical Insulation (July 1957)
954 Application Guides for: Ground-Fault Neutralizers; Grounding of Synchronous Generator Systems; and Neutral Grounding of Transmission Systems (October 1954)
955 Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Clad Switchgear (October 1955)

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DEVELOPMENT OR MANAGEMENT, MSEE, 33, Naval Academy graduate with 3 yrs postgraduate electrical, also electronics and indus management. 7 yrs supv and technical exper electrical, electronic fields. Wide knowledge weapons systems, government contracts and standards. Location desired: East, Midwest, San Francisco, South America. E-975.

ELEC ENGR, B.Sc. (Elec Engr); 34; 9 yrs exper in the manufacture and design of elec switchgear, power circuit breakers, moulded case circuit breakers, controls, electronic equipment, becoming chief engineer and mgr. Location desired: Open including Foreign. E-976.

PROJECT OR SUPERVISING ENGR, B.Sc. and M.Sc. in Elec Engrg, 27; research and development exper in control systems, 2 yrs. Design and project responsibility, steel mill controls, development switching circuits, 3 yrs. Exper in application of servomechanisms and control elements. Location desired: East or West Coast. E-977.

RAILROAD MECH OFFICER, BSEE, 32; 10 yrs exper in all phases of railroad mechanical work. Able to handle wide variety of supervisory positions, especially qualified to plan and direct maint program. Registered engr Georgia and Illinois. Location desired: South—East. E-978-867-Chicago.

INDUS MANAGEMENT ENGR, B.E.E.; M.L. Ind. Mgm't. (1958), 33; 10 yrs electric utility company. 6 yrs elec des on power plts, auxiliaries, controls and plt start-ups. 4 yrs mech and elec des, res, and development on atomic power plt. Registered. Desire management type position in company with a supervisory development program. Location desired: East, Midwest. E-979.

ELECTRICAL ENGRG—TEACHING STAFF, B.S.E.E., M.S.E.E., 35, 9 yrs teaching, mostly electrical circuits and machinery. Location desired: New England. E-980.

ELEC ENGR with electric utility company, B.S.E.E., 34; elec planning engr in power systems, 2 yrs; power station superintendent, 3 yrs; power station elec maintenance engr, 2 yrs; General Electric Company, 1 yr. Location desired: New York. E-981.

TECHNICAL ADMINISTRATOR, B.S.E.E., 36; 12 yrs exper R & D and product engrg; 7 yrs at the project or supervisory level. Desires position in new product planning or application at a management level. Location open. E-982-875-Chicago.

PLANT ENGR, CHIEF ENGR, B.S., M.S. in E.E., N.J.P.E., 41. Bldg and equipment engrg and maintenance exper. Development and application of automatic control systems. Competent leader and executive. Ex-bomber pilot. Location desired: Midwest or New York area. E-983.

ELEC DES, ASSIST OR ASSOC PROFESSOR, B.E.E. AND M.S.E.E., 32; 7 yrs consulting engrg in the design of electrical systems for industrial, commercial, institutional bldgs; 5 yrs instructor teaching courses in power, machinery and illumination. P.E. license. Location open. E-984-9653-Detroit.

INDUSTRIAL MGM'T ENGR, M.S.—Education major in Industrial Mgm't, 39; diverse background in engrg, administration, personnel and college teaching. Location desired: South or West. E-1320-San Francisco.

Positions Available

DEVELOPMENT AND DESIGN ENGINEER, graduate electrical, with considerable experience in the use of transistors as used in amplifiers, multivibrators, etc. Salary open. Location, Illinois. W-5892.

PROJECT ENGINEERS in the microwave and receiver fields; B.E.E. degree and three to five years' related experience in the field. Will be responsible for design and development of tunable, microwave receivers, broad bank antennas, filters and other microwave and receiver components. Salaries open. Location, Mohawk Valley, New York. W-5893.

INSTRUCTORS AND/OR ASSISTANT PROFESSORS for Department of Electrical Engineering. Applicants should have a Master's degree or Ph.D. degree. Teaching areas are: (1) Electro-mechanical energy conversion, embracing four undergraduate courses from electric machinery through the response to electromechanical systems; (2) Electromagnetic fields and microwaves; undergraduate courses and several first year graduate courses in this area. Salaries: Instructors, $5000; Assistant Professor, $6000 for academic year. Available September 1, 1958. Location, upstate New York. W-5899.

ELECTRONIC ENGINEER, 30-50, B.S.E.E., for development of systems. Systems and servo experience required. Salary open. Location, Ohio. W-6020.

ASSISTANT EDITOR, graduate electrical, with electrical equipment experience, for staff writing and editing position covering electric power fields. Salary, $6500-$8500 a year. Location, New York, N. Y. W-6021.

ELECTRICAL ENGINEERING DRAFTSMAN, for bituminous coal mining company. Must be familiar with the application of electricity to mining uses. Work will consist of designing substations, transmission lines, etc. Applicants should apply by letter stating education, experience, age, physical condition and salary expected. Technical education desirable but not essential. Location, Pennsylvania. W-6023(a).

ENGINEERS. (a) Senior Electronic Engineer, 35-45, with a broad, comprehensive research background in the field of electronics and electrical engineering. Must be capable of supplying technical leadership in coordination of research projects involving electronic circuit theory, digital and analog systems, solid-state devices, electro-mechanical systems, and related fields. (b) Electronic Engineer, 30-40, broad familiarity in the field of electronics or electrical engineering including considerable sales management and promotion work in the electronics or electrical engineering industry. Salary open. Location, Midwest. W-6028.

ELECTRIC POWER ENGINEER, graduate electrical, with five years' minimum experience in industrial power substation and distribution systems. Will design, write specifications, lay out electrical equipment. Some travel. Salary, $8500-$10,000 a year. Headquarters, Pennsylvania. W-6032.

WORKS MANAGER, 35-50, engineering graduate with broad manufacturing experience in electronic fields covering production, inspection, industrial engineering and purchasing, for producer of magnetic tapes and allied electronic equipment. Salary, $15,000 a year plus. Location, Midwest. W-6034.

PERSONNEL ASSISTANT, 26-34, electrical or mechanical engineering graduate, preferably with electronic equipment experience, for liaison, correspondence and reports covering engineering and technical personnel. Salary, $6000-$8000 a year. Location, New York, N. Y. W-6036.

ENGINEERS. (a) Test Engineer, graduate electrical, young, with some experience with rotating machinery manufacturer and some desire to go into test and development phases including environmental tests. (b) Electrical Rotating Machinery Designer capable of designing electrical phase of equipment of synchronous or induction type in sizes from one to 500 hp. Can use either a finished designer with some experience or a younger man with limited experience who would be willing to train. Salaries, $6000-$10,000 a year. Location, Ohio. W-6038.

CHIEF ELECTRICAL ENGINEER, electrical graduate, with at least ten years' experience in marine electrical fields covering power facilities, electrical and electronic controls and communication equipment. Salary, $10,000-$12,000 a year. Location, New York, N. Y. W-6039.

TEACHING PERSONNEL. (a) Assistant Professor, M.S. in E.E., and at least three years' teaching or industrial experience in electrical technology. Salary, for nine months, $5650. (b) Instructor, B.S. in E.E., to teach elements of electrical technology. Salary, for nine months, $4650. Extra for summer and night courses. Location, New York Metropolitan area. W-6042.

ASSOCIATE PROFESSOR OR PROFESSOR for department of electrical engineering, to do research work and teaching at the graduate level in electronics and communications. Salary commensurate with experience and education. Location, South. W-6050.

SENIOR ELECTRICAL DESIGN ENGINEER, 25-50, graduate electrical, with experience in the design of transformers, power supplies, magnetic amplifiers, delay lines and pulse forming networks. Should have practical knowledge of drafting practices and procedures; general knowledge of production practices and equipment; methods engineering; production planning, etc. Will be responsible for design of above listed products. Salary, $10,000-$12,000 a year plus company sponsored benefits. Company also pays moving and travel costs. Location, northeastern New York State. W-6063.

SENIOR ENGINEER, Electrical, 26-35, graduate electrical, with minimum of five years' experience in development of commercial and military circuitry. Experience should include any five of the following specialized fields: Pulse techniques, RF techniques, power supplies, audio circuitry, test equipment, digital techniques and systems. Salary, to $13,000 a year. Location, New Jersey. W-6066(a).

ENGINEERS. (a) Electronics Engineer, B.S.E.E., 24-30, with a minimum of two years' experience in any of the following: Telemetry, fire control systems, pulse and digital work Experience preferable with transistor circuits and/or magnetic core circuits. Salary, $8000-$10,000 a year. (b) Junior Electronic Engineer, B.S.E.E., 21-25, with

some practical experience in development of commercial and military circuitry desirable. Salary, to $7000 a year. Applicants must be U.S. citizens with previous clearance for classified work. Location, New Jersey. W-6067.

DESIGN-DRAFTSMAN, electrical engineering graduate, with design and layout experience covering electrical facilities in commercial, institutional and industrial buildings. Salary, $6500-$7800 a year. Location, Virginia. W-6083(b).

ELECTRONIC ENGINEER, Bachelor's degree, with ten years' experience in radar or pulse circuitry, for research and design work. Salary open. Location, New York, N. Y. W-6084.

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ENGINEERS (a) Planning Engineer, electrical graduate, with five to ten years' electrical utility experience covering planning, costs and economics of operations. Salary, $8000-$10,000 a year. (b) Field Engineer, young, electrical graduate, with telephone equipment experience for plant engineering and operations. Salary, $6000-$7000 a year. Location, New York, N. Y. W-6096.

SALES ENGINEER, graduate mechanical or electrical, with five or more years' experience selling to industrial accounts for company manufacturing plastic extrusions for industry. Salary open. Travel four to five days a week, home week-ends. Territory, New England and New York State. W-6098.

INSTRUCTOR OR ASSISTANT PROFESSOR, M.S. degree preferred, but either a young engineering graduate or a mature engineer with a B.S. or M.S. degree will be considered for Department of Mechanics and Electricity. Must be able to teach any of the the following subjects: Applied mechanics, fluid mechanics, strength of materials, graphic statics, physical thermodynamics, applied electricity (electrical machines and associated circuits), industrial electronics and laboratories. Salary range, for ten months, $5800-$6300; will reimburse moving expenses up to a maximum of $400. Location, Midwest. W-6099.

CHIEF TEST ENGINEER, graduate engineer or physicist, background in thermodynamics, metallurgy, nucleonics, electro-mechanical controls and computer applications, with five or more years in engineering or scientific laboratory. Will direct an existing group in engineering tests of industrial package steam generators, and related components, precision temperature control and a wide range of electro-mechanical devices in well equipped plant. Salary, $7500-$12,000 depending on qualifications. Employer will pay placement fee. Location, Chicago. C-6813.

CHIEF ENGINEER — Electrical Systems, M.S.E.E. or allied, with a minimum of five years' recent supervisory experience including management of group research engineers and technical persons on circuitry design device development of electrical, mechanical and instrument systems and sub-systems. Must know preparation of cost estimates, technical proposals and be able to establish and maintain budgets, reports and progress for manufacturer. Salary, $10,800-$15,000 a year. Location, San Francisco Peninsula. S-3472.

PROJECT, DESIGN, DEVELOP-ELECTRIC CIRCUITS, electrical engineer, with heavy math, a minimum of four years' experience in design, development of electric circuits; also be able to apply high level math in determining electric parameters from displays on Cathode Ray tubes for electrical manufacturer. Salary, to $12,600 a year. Location, San Francisco Peninsula. S-3474.

DEVELOPMENT, DESIGN, TEST-CATHODE RAY: (a) Senior Electrical Engineer, Electric Physics; with five years' experience in circuitry and/or vacuum tube design, a knowledge of Beam deflections including forces and deflections, and development and application of vacuum systems equipment, also technology of demountable test equipment and glass. Salary, to $10,800 a year. (b) Engineer, electrical, strong on Beam Dynamics and circuitry. Salary to $8400 a year. (c) Junior, electrical, capable of circuitry. Salary, to $6600 a year. Location, San Francisco Peninsula. S-3475.

MANAGER—Power Systems, electrical engineering training, for utility with 2000 customers, 130 miles of transmission and distribution lines, 60 KV to 7.2 KV. Must have high voltage transmission line and substation experience, also watthour meter experience and be able to handle up to 20 employees as manager of the system. Good opportunity for man past 50. Salary, $6600 a year to start. Location, Nevada. S-3515.

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OPPORTUNITIES WHICH LEAD TO MANAGEMENT

As an independent leader in the field of high permeability magnetics, we are expanding our creative engineering leadership. These are "threshold to management" positions for which we need

ELECTRICAL AND ELECTRONIC ENGINEERS

Choose your own avenue of development or application work in instrumentation, magnetic circuitry and magnetic materials.

If you can qualify for a really bright future, send experience summary to

Mr. Keith Krewson, Mgr. of Personnel

MAGNETICS inc.

BUTLER 2, PA.
(near metropolitan Pittsburgh)

FEEDBACK CONTROL SYSTEMS CONFERENCE

The second Feedback Control Systems Conference was held April 21-23, 1954 at Atlantic City, N. J. The papers, as prepared by their respective authors are included in publication S-63. The technical papers and scheduled demonstrations covered the following fields and subjects:

Industrial regulators
Tracer machine tools
Process control
Nucleonics
Aircraft engines
Flight path control
Fire control
Platform stabilization
Flight simulators
Computers
Test equipment
Magnetic Amplifiers
Potentiometers
Gears and dampers

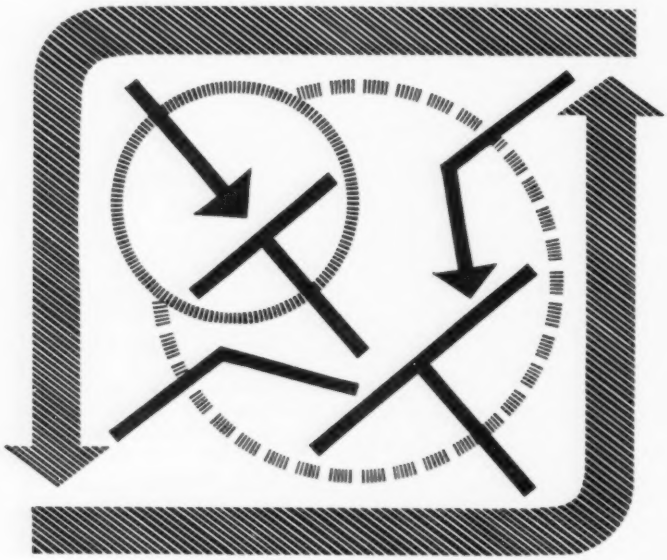
The preceding list indicates a wide range of applications of feedback control as well as the diversity of components.

This 158-page publication, S-63, is available at the price of $3.50 to members and nonmembers from the Order Department

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

33 West 39th Street

New York 18, N. Y.



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Aware that engineering today's defense systems would require new and fresh approaches, RCA management has consistently placed a premium on creativity. Fertile minds have long been at work at RCA. Your individual thinking is welcomed. You, in turn, will be stimulated by RCA's creative atmosphere. Fields of interest:

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BEImont 5-5000

Or: Mr. C. B. Gordon,
RCA, Dept. B-19F
Building 10-1, Camden 2, N.J.
WOodlawn 6-3300

RCA

RADIO CORPORATION of AMERICA

DEFENSE ELECTRONIC PRODUCTS

Trade Literature

(Continued from page 64A)

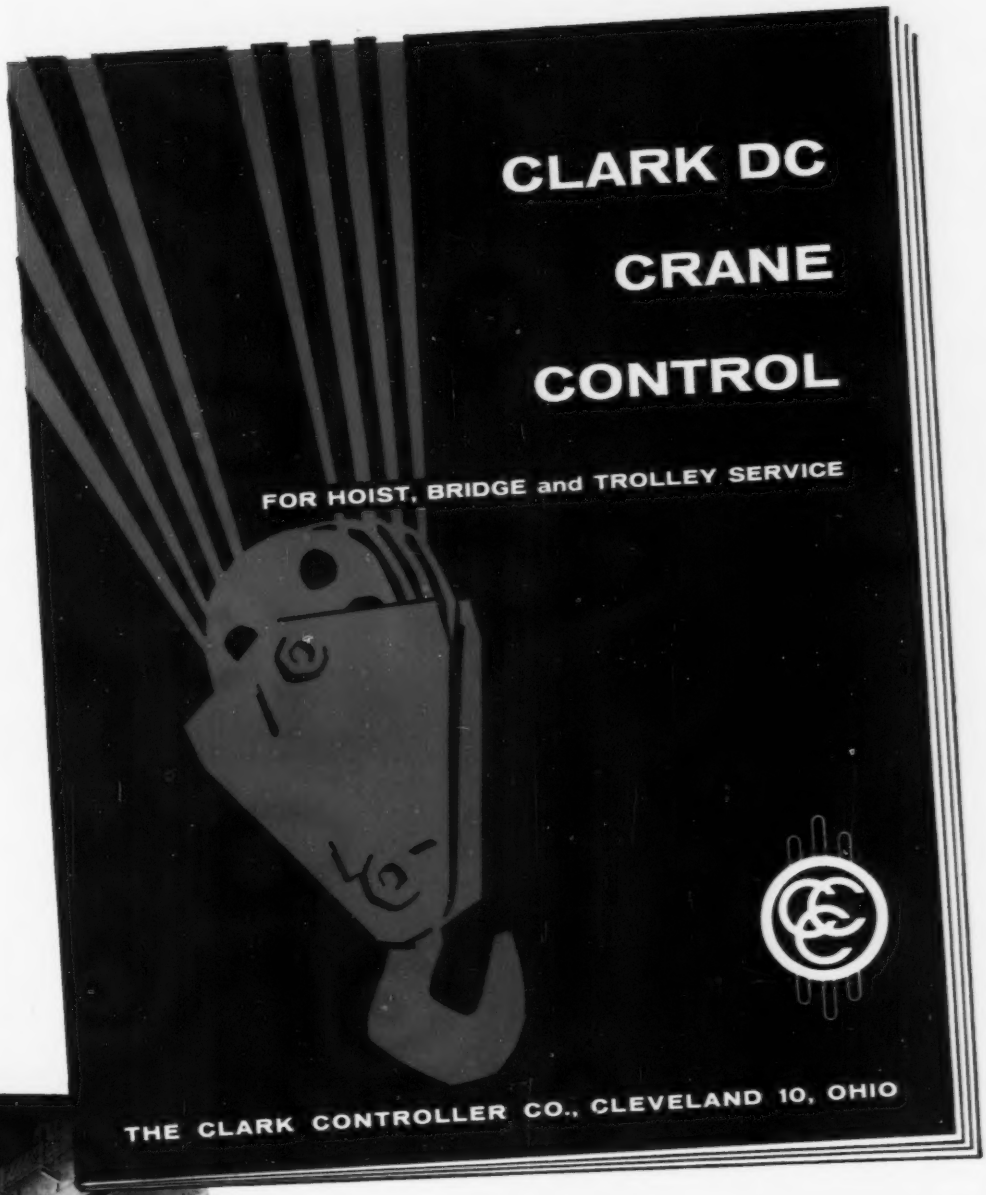
Tape-Wound Core Performance Limits Now Published. Tape-wound cores and the field of high-permeability magnetics have come of age with the publishing of guaranteed tape-wound core performance data. This standardization of core performance within narrow limits by Magnetics, Inc., Box 230-T, Butler, Pa., puts cores on the same catalog basis as vacuum tubes, resistors, and other components with published characteristics. Performance data issued by the firm includes limits for maximum, minimum, and nominal B_m, B_r/B_m, H_c, and gain, for 1-, 2-, 4-, and 6-mil Orthonol (registered trade mark) and square Hy Mu-80 tape. Previous data available for standard cores provided only typical characteristics that ranged from the highest point of 1-mil tape to the lowest point of 6-mil tape.

Potting and Casting Data. Four improved potting and deep casting compounds which give excellent results in a variety of electrical uses are described in a 4-page technical data sheet No. *102577* "Urethane Potting and Deep Casting Compounds," recently issued. Copies of this data sheet may be secured without charge by addressing Allied Chemical & Dye Corp., National Aniline Division, 40 Rector St., New York 6, N.Y.

Rubberized Abrasives Catalog. Rubberized abrasives for deburring, smoothing, and polishing applications are thoroughly covered in the latest Cratex industrial catalog recently published. The 8-page catalog tells what Cratex rubberized abrasives are, how they are used and what they can do on a broad list of high precision manufacturing operations on tools, dies, molds, instruments, models, and component parts. This industrial catalog is available free on request from Cratex Manufacturing Co., 1600 Rollins Rd., Burlingame, Calif.

High-Voltage Power Cables Bulletin. A 4-page technical bulletin describing neoprene-sheathed high-voltage power cables for 3- to 15-kv service is now available. Rome Cable's ozone-resisting insulations—oil base (Rozone) and butyl base (Rozone A)—are discussed in detail. For free copies write to: Publications Division, Rome Cable Corporation, 332-400 Ridge St., Rome, N.Y., and ask for Bulletin *RCD-701*.

Printed Circuit Connector Bulletin. This illustrated bulletin gives specifications, outline dimensions, and general information on the new Series *600-93* printed circuit connector. Featured here are exclusive bellows action contacts that accept printed circuit board thickness of 1/16 inch to 1/8 inch with no distortion or stress. For a free copy of this Series *600-93* technical bulletin, write to Electronic Sales Division, DeJur-Amsco Corporation, 45-01 Northern Blvd., Long Island City 1, N.Y.



Clark has engineered and built control systems for all sizes and types of DC cranes, covering all five NEMA I.C1-42.01 Service Classifications. The hot ladle crane illustrated is an example of Group V, Steel Mill and Heavy Industrial.

Interested in DC Cranes?

This 20 page book outlines the basic principles of DC crane control, and provides the essential technical information you should have to select the controls best suited to your particular DC crane requirements. Profusely illustrated with photographs, charts and diagrams, the book explains in detail the circuits and components required for safe, dependable crane operation. As a major supplier of DC control of all types for over 30 years, The Clark Controller Company has pioneered and developed many of the advancements in modern DC crane control. This book provides an authoritative report of these developments.

Write today for your copy of this informative book. Ask for Bulletin 9100.

The CLARK CONTROLLER *Company* 11G

Everything Under Control 1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

How does this square with your own experience?

(A CHECKLIST FOR EE READERS)

Advertising in EE is designed, primarily, to direct you to sources of supply: apparatus, materials, components, equipment.

But there are additional benefits to be gained directly from information which companies include in their technical advertising.

For example: in replying to a recent survey by a leading marketing magazine*—22 of the nation's top engineers cited some 26 areas in which information they read in advertising was of specific service.

Their list is in the column at the right. Check it yourself—and see if it doesn't square with your own experience!

*Tide magazine

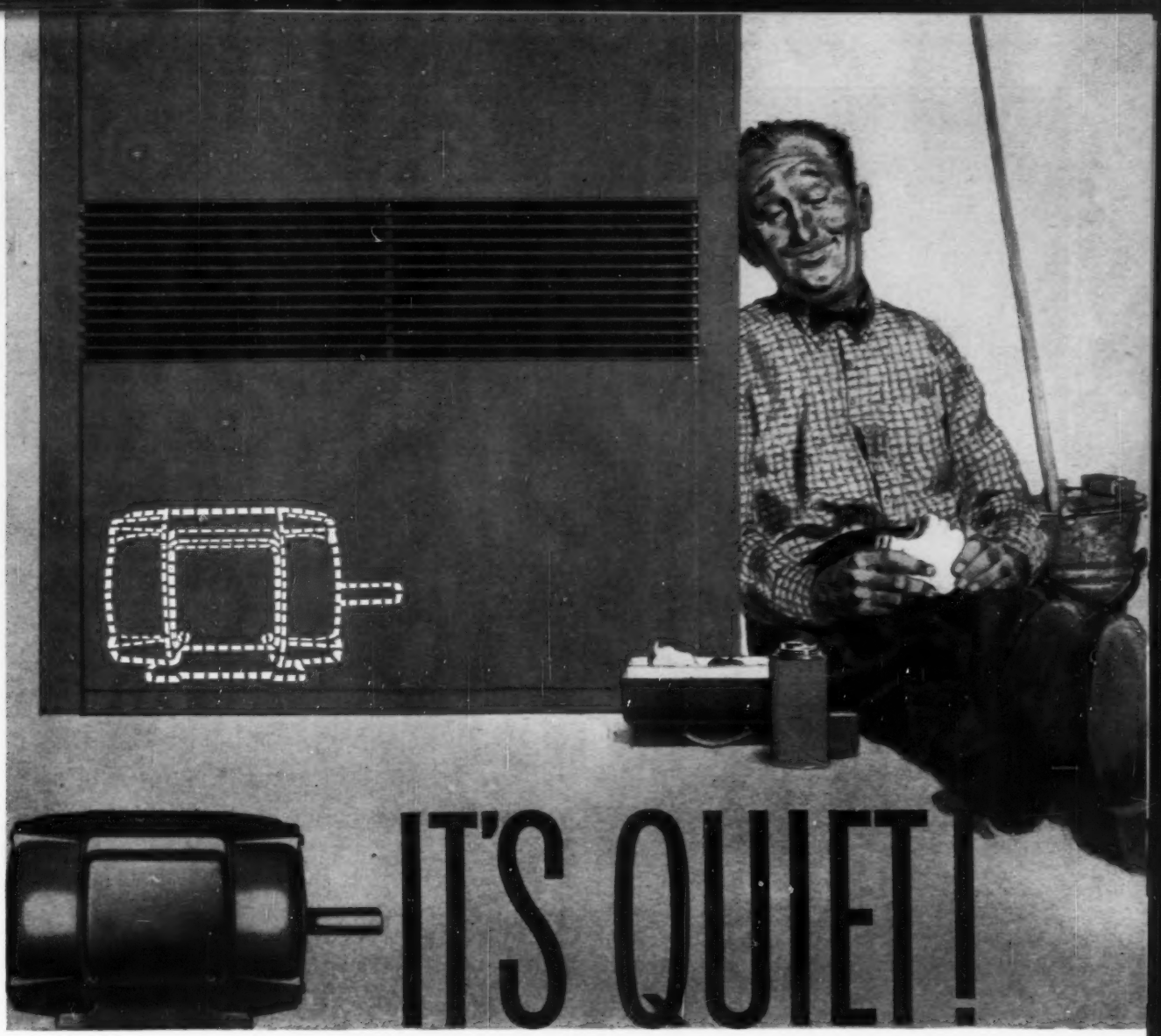
CHECK AND COMPARE . . .

(with your own experience) these benefits leading engineers said they obtained from advertising:

- ☐ reduced maintenance costs
- ☐ improved quality
- ☐ cost reduction
- ☐ simplified manufacture
- ☐ increased capacity
- ☐ improved materials
- ☐ improved appearance
- ☐ simplified processes
- ☐ improvements in design components
- ☐ higher speeds and feeds
- ☐ aided research
- ☐ reduced spoilage
- ☐ cut construction costs
- ☐ improved finishes
- ☐ improved automatic features
- ☐ better control
- ☐ eliminated shut downs
- ☐ reduced assembly steps
- ☐ improved safety
- ☐ power economy
- ☐ economy in first cost
- ☐ improved plastics
- ☐ lower cost per hour of use
- ☐ improved employe morale
- ☐ utilized smaller space
- ☐ obtained personnel

It will pay you to read advertising regularly in **ELECTRICAL ENGINEERING**

. . . the electrical engineers own magazine



. . . the Westinghouse Life-Line "A" motor

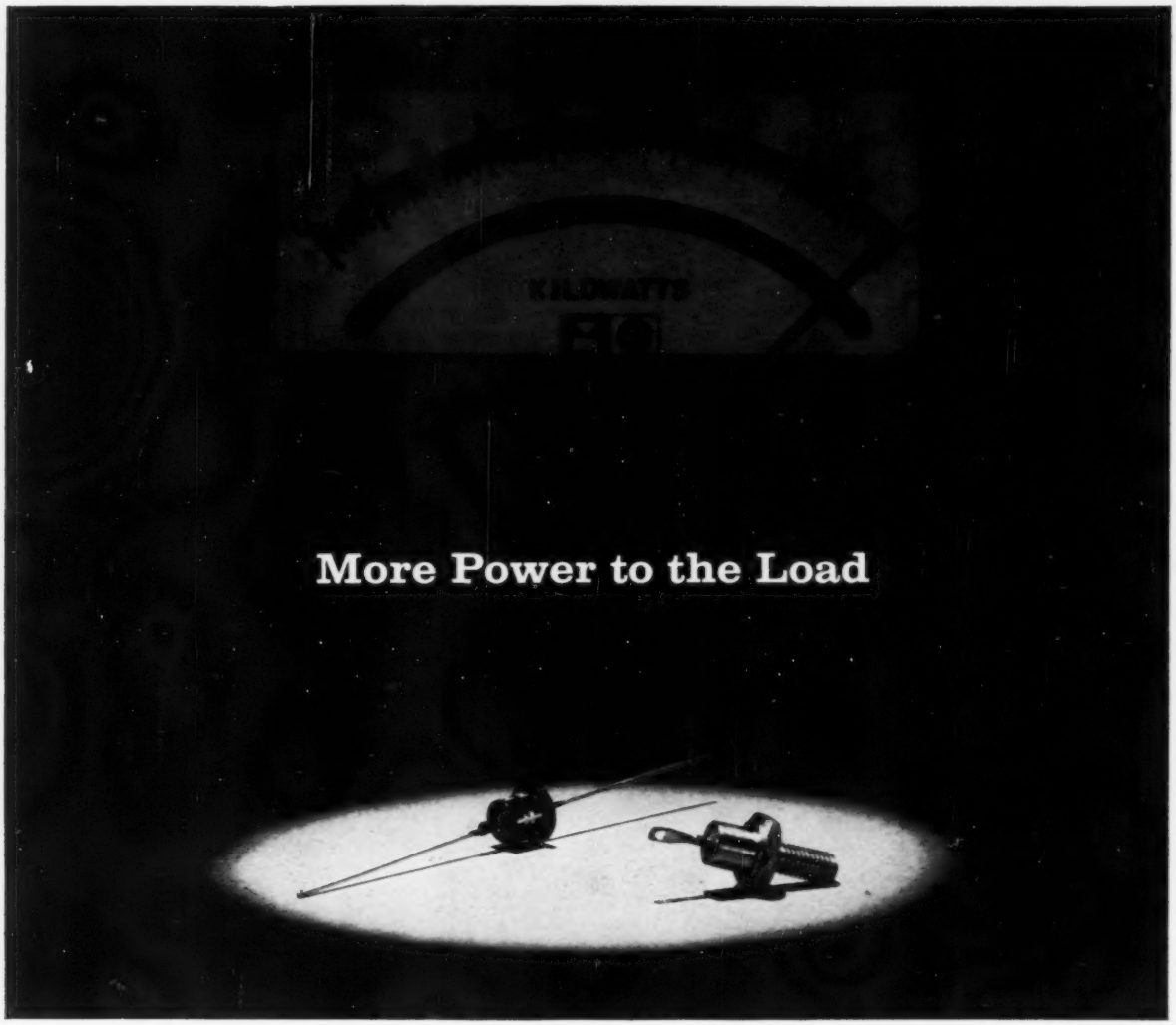
Everybody appreciates a motor which runs quiet . . . especially when it comes to motors for air conditioning systems.

That's why more and more people find the Westinghouse Life-Line® "A" the ideal choice for air conditioning units in industrial and commercial establishments . . . places where quietness counts. The Life-Line "A" is sound-engineered; it is the most quiet standard motor available today. Precision manufacturing, dynamically balanced rotor, well-balanced, low-velocity ventilating system and minimized vibration make the Life-Line "A" the motor with the built-in hush.

Maintenance is a thing of the past, too. Prelubricated bearings which keep grease in, dirt out, Bondar® and Bondite insulation and close-tolerance machining offer the nearest thing to a service-free motor.

For complete information, contact your nearby Westinghouse representative. Or, write Westinghouse Electric Corporation, P. O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa. J-22126

YOU CAN BE *SURE* . . . IF IT'S Westinghouse



Hughes medium power, silicon rectifiers

The exceptionally high efficiency of these rectifiers, obtained by advanced development and construction techniques, makes possible power supply design which was previously impossible. Efficiency like this means less power loss in the rectifier and, for a given size of rectifier, more power to the load. Cooler operation also results, thereby contributing increased life since there is less heat to dissipate.

In most instances, the voltage drop across the rectifier is so small—and it is constant throughout the life of the rectifier—that it may be neglected in power supply design. The low drop improves regulation of the power supply too.

So specify the types listed at right and capitalize fully upon the advantage of high rectifier efficiency. In addition to the types shown, Hughes has two groups of 1N-numbered units, one with a lead-mount configuration and the other in the standard JETEC 7/16″ hex package.

For literature or a visit from one of our sales engineers, please write: HUGHES PRODUCTS, Semiconductor Division, International Airport Station, Los Angeles 45, California

STUD MOUNT TYPES

	Peak Inverse Voltage (Volts)	Average Rectified Current @ Specified Case Temperature (Amps max.)	(Degrees C)	Average Inverse Current (mA, max.)*
HR10671	100	3.0	150	0.5
HR10673	200	3.0	150	0.5
HR10675	300	3.0	150	0.5
HR10677	400	3.0	150	0.5
HR10679	500	2.0	135	0.5
HR10681	600	2.0	135	0.5

LEAD-MOUNT TYPES

	Peak Inverse Voltage (Volts)	Average Rectified Current @ Specified Ambient Temperature (mA max.)	(Degrees C)	Average Inverse Current (mA, max.)*
HR10422	100	350	100	0.1
HR10423	200	350	100	0.1
HR10424	300	350	100	0.1
HR10425	400	350	100	0.1

* Averaged over one cycle at full rated conditions of current, voltage, and temperature with a resistive load.

Creating a new world with ELECTRONICS

HUGHES SEMICONDUCTORS

HUGHES PRODUCTS

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SALES ENGINEERS WANTED

for Chicago and Houston. Prefer men with Electrical, Mechanical or Chemical Engineering degrees. Successful applicants will receive three months' intensive training at factory in Waterbury, Connecticut before assignment to district office. Prefer men between 25 and 30 who can start as trainees. Previous sales and instrument experience desirable but not mandatory. Those interested in Chicago opening address reply to S. E. Gewin, District Manager, THE BRISTOL COMPANY, 351 E. Ohio Street, Chicago 11, Illinois. Those interested in Houston opening address reply to E. A. Merwin, District Manager, THE BRISTOL COMPANY, 3617 W. Alabama, Houston 6, Texas.

ELECTRICAL ENGINEER

Address all resumes, stating salary requirements to

MR. JOHN E. BAKER

Westinghouse

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First in Atomic Power

AC MOTOR DESIGNER

E.E. degree. Experience necessary in AC induction motor design. Knowledge of materials and fabrication methods desirable.

Specific responsibilities will be in the development and design of motors used primarily in pumping application.

Must keep informed as to the latest developments & materials and design techniques.

Relocation expenses paid to qualified applicant. Many liberal employe benefits.

Conference on Magnetic Amplifiers (August 1957)

Publication T-98 is sponsored jointly by the American Institute of Electrical Engineers, Committee on Magnetic Amplifiers, and by the Institute of Radio Engineers, Professional Group on Industrial Electronics. The Special technical conference on magnetic amplifiers was held in Pittsburgh, Pa., September 4-6, 1957. The 264-page proceedings consist of 18 informative papers. Price $4.00. Send orders to:

Order Department
American Institute of Electrical Engineers
33 West 39th Street
New York 18, N. Y.

Midwest Manufacturer Wants ELECTRICAL ENGINEER

Experienced in Sales and Administration. Some traveling involved contacting Field Representatives and Electric Utilities. Good salary and extra benefits. The Company is located in a city of less than 100,000 with cultural and recreational advantages. Fine working conditions and opportunity for advancement.

Please give all information regarding education, experience and minimum starting salary.

Box 624
Electrical Engineering
33 W. 39th Street
New York 18, N. Y.

CLASSIFIED ADVERTISING

For help and situations wanted, $2.00 per line, minimum 5 lines, maximum 30 lines. Sale and purchase of used machinery, etc., $2.50 per line, not available to dealers. Address orders to: Classified Section, ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y.

When answering an advertisement, send all replies to box number specified, c/o ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y., unless other address is given.

Positions Open

PROFESSOR OF ELECTRICAL ENGINEERING—to teach and do research in the field of communications. Should have Ph.D., teaching and research experience. $9,400-$12,000. Write Box 468.

ELECTRICAL ENGINEER — Electrical Engineer interested in electrical design of power plants or industrial plants. Experience not required. Excellent opportunity with consulting engineering firm in Middle West. Liberal benefit plans and good working conditions. Send resume of education and experience with statement of salary requirement to: Box 492.

GRADUATE ASSISTANTSHIPS are available at a university in the Southeast for September 1958. Assistants may obtain the Master of Science degree in Electrical Engineering in twelve months. Tuition free. Box 569.

PROFESSOR OF ELECTRICAL ENGINEERING—Primarily to Participate in Graduate and Research Program. Opportunity to Cooperate in Development of Well Equipped New Laboratory Space and Facilities. Should have Ph.D. Location, East. Box 617.

ASSISTANT OR ASSOCIATE PROFESSOR OF ELECTRICAL ENGINEERING, to teach under-graduate courses in communications. M.S. degree minimum, salary six to nine thousand for nine months. Two thousand dollar possible summer. Dean of Engineering, University of Santa Clara, Santa Clara, California.

GENERAL ELECTRIC ADVANCED ELECTRONICS CENTER at Cornell University has openings for experienced electronic engineers and physists. As the Advanced Engineering Component of the Light Military Electronic Equipment Department, the Center is responsible for Applied Research and Advanced Development of Airborne Electronic Equipment. Current work at the Center includes Electronic Warfare, Radar, Communications, Data Processing, Weapons Systems Engineering, Proximity Fuses, Magnetic Amplifiers, Human Engineering, Infrared and Transistors. Replies stating education, experience and salary requirements should be addressed to Dr. Paul Doigan, General Electric Company, Advanced Electronics Center at Cornell University, Ithaca, New York. All replies will be kept confidential.

ASSISTANT OR ASSOCIATE PROFESSOR of Electrical Engineering at state supported college located on Texas Gulf Coast. Excellent opportunity for man with M.S. or Ph.D.; salary depending on background and qualifications. Permanent position in expanding department. Address reply to Director, Division of Engineering, Texas College of Arts and Industries, Kingsville, Texas.

ELECTRICAL ENGINEER — Excellent opportunity in engineering department of a Western Wisconsin Utility. Experience and knowledge necessary in fault current calculation; relay and fuse coordination; instrument and control circuit design; installation and testing of relays, meters and switchgear control. Experience desirable in generation and transmission system operation. Opportunity for wide variety of other engineering work. Write Box 625.

ELECTRICAL ENGINEER — Immediate requirement for Sales Engineer, on permanent basis, age 25-40, to promote a well-known line of drop forged hi-voltage transmission line clamps and hardware. Should have E. E. degree, power option, and minimum of five years' experience in transmission and distribution field. Our medium-sized, well-known, long-established company with AAAA +1 financial rating is located in community of 18,000 in Central New York Finger Lake region. Salary commensurate with background. No drop forging experience necessary. Excellent working conditions with sound fringe benefit and retirement program. Write, giving complete qualifications to set up personal interview: The Brewer-Titchener Corporation, Mr. Harold J. Flinn, Treasurer, Cortland, New York. All replies kept in strictest confidence.

Positions Wanted

SWITCHGEAR ENGINEER, H. V. Circuit Breaker Design; Short-Circuit and H. V. Testing; Arc Control Design; Moulded case breaker design; Substations; location open; Box 628.

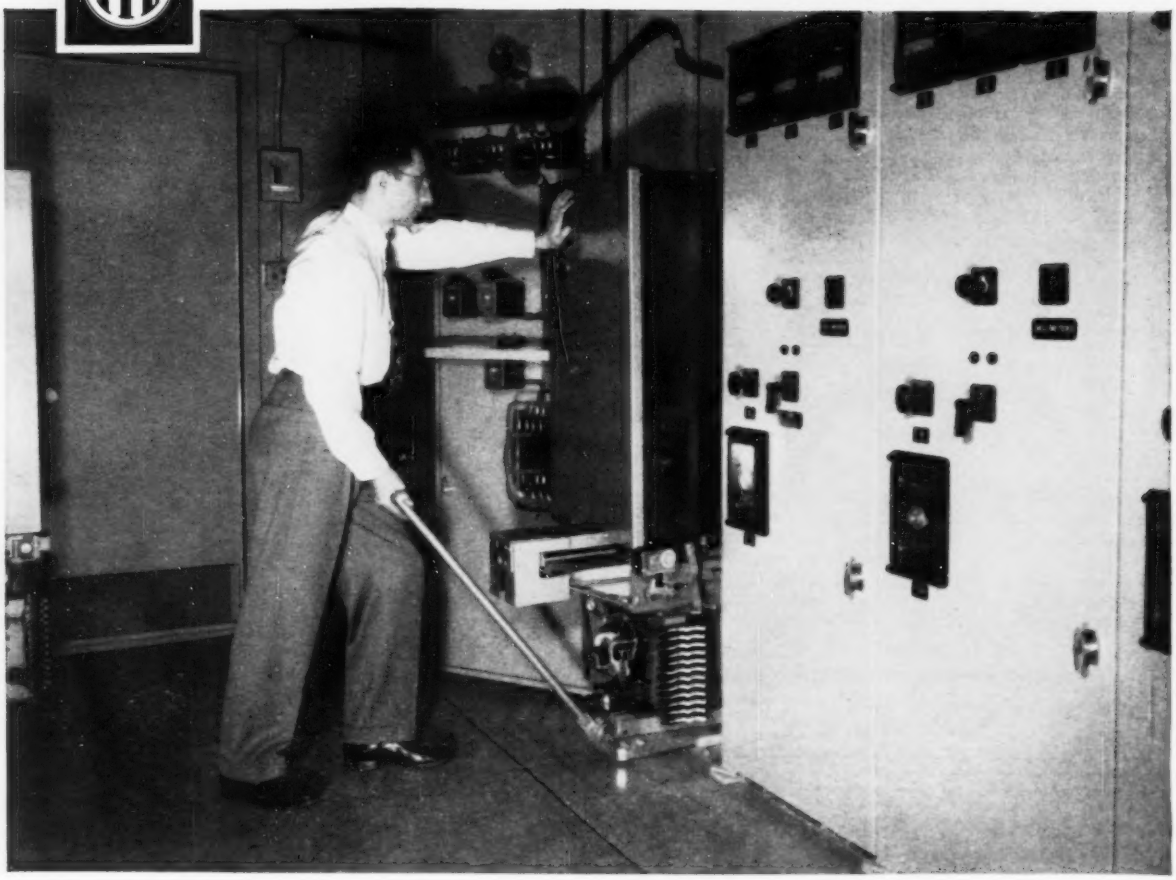
ENGINEER, Ph.D., teaching experience; 25 years in European utility practice, engineering and executive positions; interested in university positions in U. S. or Canada. Box 626.

FRENCH ME & ELECTRICAL ENGINEER, 31, ex-manager small contractor, excellent education, energetic, work organization, engineering and construction, power distribution, electrical utility; lines and substations; looks for responsibility. Box 627.

A.I.E.E. TRANSACTIONS wanted to buy for cash back volumes and sets also other scientific and technical Journals.—E. E. ASHLEY, 27 East 21st Street, New York 10, New York.

ENGINEERS', SCIENTISTS' AND TECHNICIANS' RESUMES our specialty. Write for "How to Write Your Resume" with sample guide and forms—$1.50 postpaid. The Resume Workshop, Orville E. Armstrong & Co., 55 West 42nd Street, Dept. E, New York 36, N. Y.

METAL-CLAD SWITCHGEAR



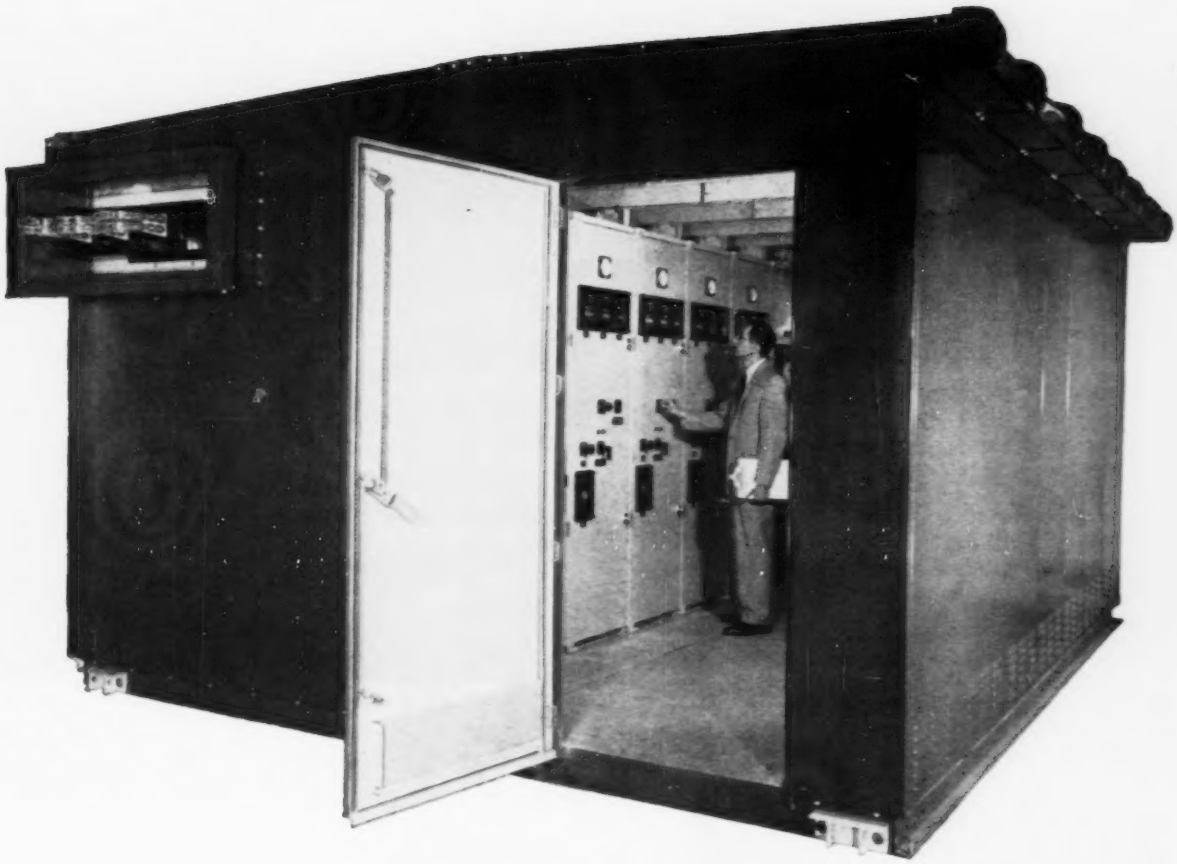
Walk-In Outdoor Shelters Now Being Installed

Hinged rear doors afford easy access to rear of switchgear.

Now available are I-T-E Walk-In Shelters for housing metal-clad switchgear in outdoor locations. These are being produced to meet a growing demand, and already two installations of this I-T-E development are in progress. They render the big service of permitting personnel to maintain switchgear in defiance of weather. These I-T-E Walk-In Shelters feature all the following advantages:

- **Completely gasketed doors, side sheets and frames. Doors are sealed with cellular neoprene sponge; side sheets and frames are sealed with wool felt, impregnated with chromite.**

- **All parts are treated for rust resistance, painted and baked prior to assembly. This protects the metal against rust and corrosion. Further, the bottom of the entire unit is undercoated.**



to Protect Service Personnel Against Weather

- **The shelter is completely self-sustaining. It is equipped with ventilating louvers, lights, heating units and convenience outlets.**
- **The entire structure is strong enough to be pier mounted, if desired, with resulting increased savings.**
- **Hinged rear doors afford easy access to rear of switchgear.**
- **Transformer connections can be made through weatherproofed throats, roof bushings, or underground cable, as required.**
- **Space is provided for storing grounding devices or spare circuit breakers.**
- **Nonskid flooring insures safe footing for operating personnel.**
- **Standard shelters are available for any size switchgear assembly.**

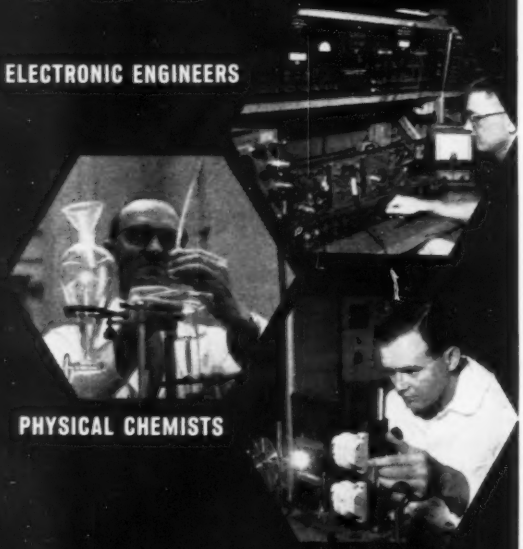
For complete information about I-T-E Walk-In Shelters for switchgear, contact your nearest I-T-E sales office or write Switchgear Division, I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa. In Canada: Eastern Power Devices Ltd., Port Credit, Ont.

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA

ON SEMICONDUCTOR FRONTIERS

YOU can help 'beat the heat' at 200°C

ELECTRONIC ENGINEERS



PHYSICAL CHEMISTS

SOLID STATE PHYSICISTS

ELECTRONIC ENGINEERS at TI are beating the semiconductor heat barrier with devices that will operate at 200 degrees centigrade and higher – twice the boiling point of water! Working closely with other scientists on the TI team, they continually explore new fields in electronics. Under the hot glare of infrared light which simulates extreme operating conditions, the engineer shown above is testing the newest TI silicon power transistor operating in conjunction with the totally new *Sensistor* temperature-sensing silicon resistor.

On this frontier, there is plenty of room for electronic engineers, physical chemists, solid state physicists, and others to build America's electronic future. If *you* are interested in joining other leading engineers and scientists at the industry's most modern research, development and production facilities – write or call for more information on 28-year-old Texas Instruments, recognized leader of the semiconductor industry. You will discover up-to-date supplemental benefits – profit sharing, insurance, retirement programs, and company-sponsored educational assistance.

Semiconductors and Other Components – Transistors, diodes, rectifiers, capacitors, resistors, transistor circuit applications, test equipment, mechanization. Write Harry Laur.

Electronic and Electromechanical Apparatus – Radar, sonar, infrared, optics, navigation, magnetics, telemetering, communications, computers, transformers. Write R. E. Houston.

Research and Manufacturing – PhD level for research, development and applications: solid state device technology, ferromagnetics, infrared, microwave, magnetics, digital computers, radar, sonar, telemetering, etc. Engineers for production, planning, purchasing, cost analysis, etc. Write A. E. Prescott.

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in worldwide nuclear projects

EXPERIENCED NUCLEAR ENGINEERS

ANALYTICAL

Degree essential. Experience as required.
Preliminary analysis: Conduct preliminary analysis and design of overall power reactor systems and components.
Shielding analysis: Advanced studies and analysis on stationary and mobile plants.
Systems analysis: Engineering direction on reactor plant design.
Control analysis: Reactor kinetic and overall nuclear power plant control. Hazard analysis. Analog and digital computers.
Core analysis: Includes criticality, temperature, void and power coefficients, control effectiveness and fuel cycles.
Stress analysis: Structural, thermal, and dynamic stress analysis of high temperature reactor systems.
Heat transfer analysis: Reactor systems – dynamics and thermo-dynamics of fluid flow.
Operations: Foreign and domestic – for checkout, start-up and training.

DEVELOPMENTAL

Requires related experience and applicable degree.
Fuel elements: Metallurgists for R&D on nuclear fuel materials, including radiation effects, evaluation of uranium and thorium alloy, and ceramics. Also for mechanical fabrication development for these materials.
Instrumentation and control: Experienced physicists and EE's for design and development of advanced design vacuum tube, transistor, and/or magnetic amplifier control and instrumentation components. Design and analysis on reactor control systems, using stability and transient response techniques.
Nuclear fuel reprocessing: Inorganic and physical chemists for developmental studies and experimental work. Experience with radioactive materials and high temperature processes desirable.

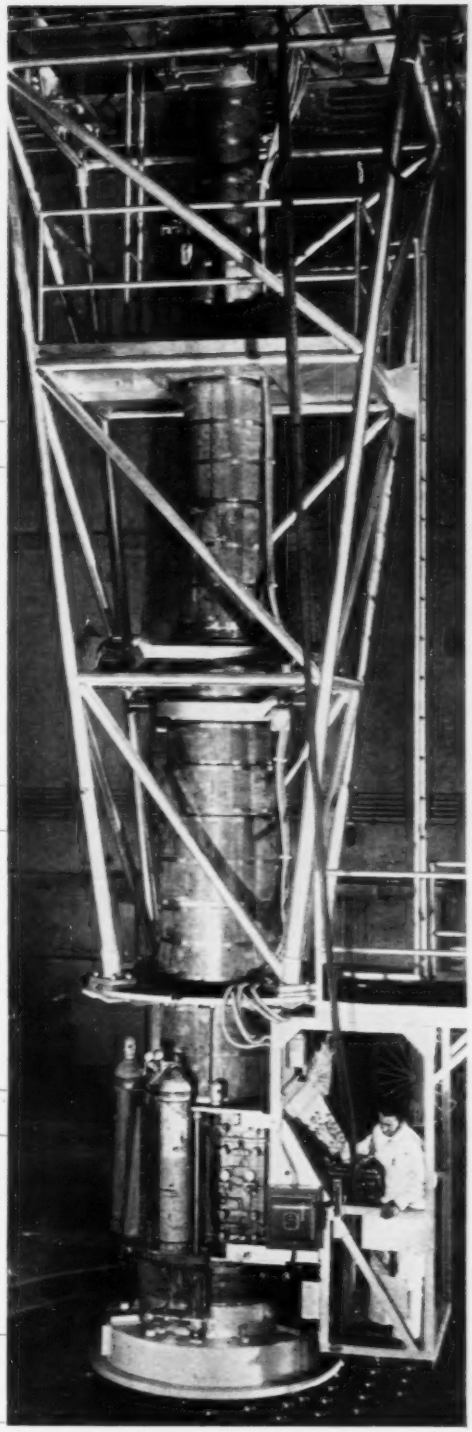
DESIGN

Senior openings. Degree required. Nuclear experience essential.
Control mechanisms: Control and safety rods, drives and allied tooling.
Reactor core components: Moderator cans, fuel elements, core supporting structures.
Machine design: Heavy mechanical.
Electrical: Reactor control and power systems.
Process systems and equipment: Pumps, Heat transfer equipment.
Facilities: Mechanical systems.
Process instrumentation: Reactor, auxiliary, and control systems.

Other opportunities in:
Theoretical, Experimental, Solid State Physics, Health Physics, Materials Research, Mechanical Component Development.

Write for more details of exciting career opportunities at AI.
Mr. E. F. Newton, Personnel Office, Atomics International
15330 Raymer Street, Van Nuys, California
(In the suburban San Fernando Valley, near Los Angeles)

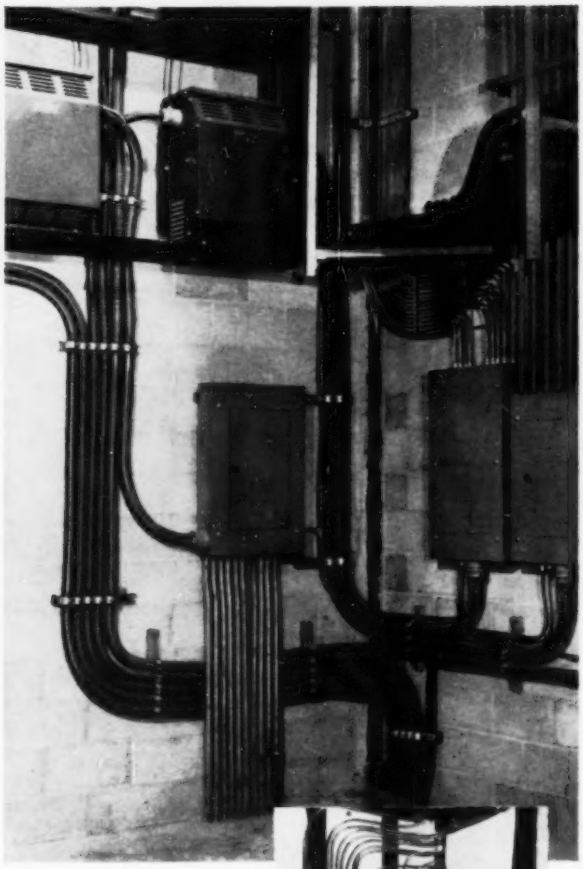
ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM



SRE Fuel Handling Cask. The Sodium Reactor Experiment and the Organic Moderated Reactor Experiment are both in successful operation. Plans for several central station plants based on these experimental power reactors are underway. AI is also conducting an advanced power reactor study for Southwest Atomic Energy Associates. Overseas, AI has already sold 5 reactors, and is affiliated with ASEA of Sweden and the new company INTERATOM (with DEMAG, West Germany).

the right combination for industrial power needs!

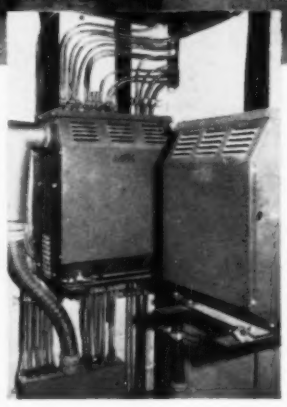
Only General Cable manufactures both...



Installation at the St. Regis Paper Company, Jacksonville, Fla. plant.

TYPE m.i. CABLE

for distribution, control and lighting circuits



INTERLOCKING ARMORED CABLE

for primary power feeder circuits

Easy to install in all locations, both Safety M I Cable and Interlocking Armored Cable require no mechanical protection, thus lowering costs of installation and minimizing space requirements. These constructions are easy to train around equipment or structural members, assuring the absolute minimum of interference, and present a neat, functional appearance. In addition, Safety M I Cable has unequalled physical and electrical properties: it is completely resistant to moisture, aging, nearly all chemicals, and operates at continuous high temperatures. For truly modern wiring in your plant, specify Safety M I Cable and Interlocking Armored Cable. And remember; only General Cable makes them both.

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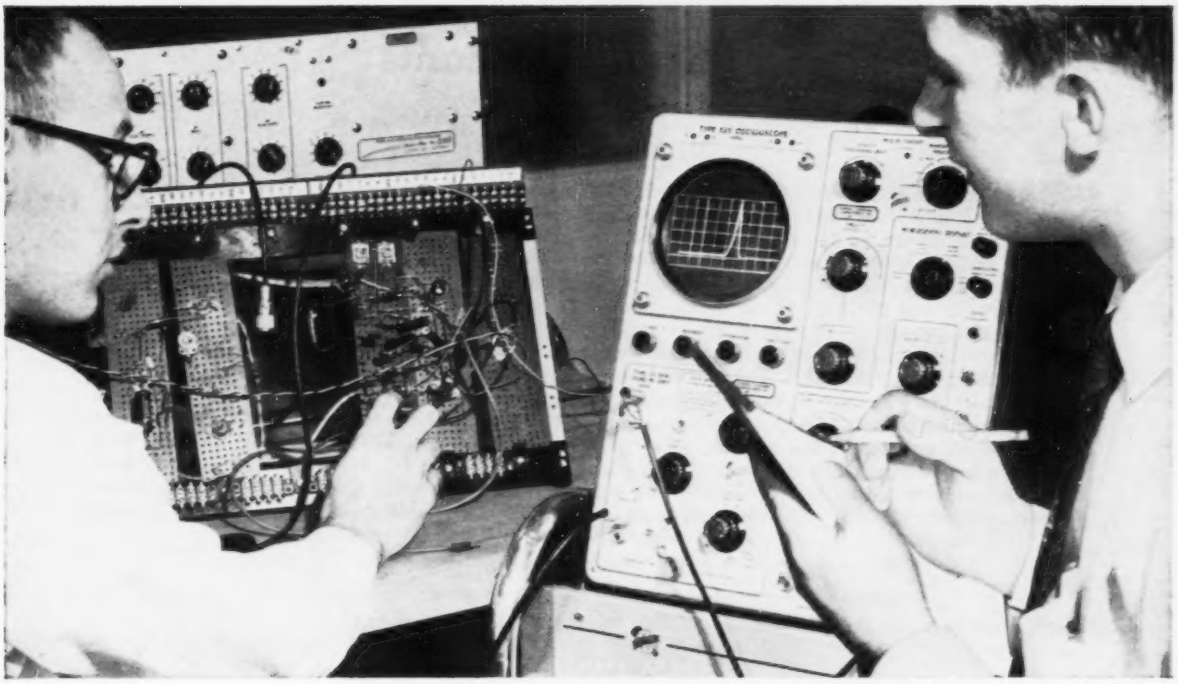
The GENERAL idea on Engineering Careers



General Telephone engineers using a "535" oscilloscope to check high-speed circuitry.

We're applying high-frequency pulse techniques to telephones of the future

IN DESIGNING tomorrow's telephone systems, General Telephone Laboratories is applying electronics to provide new standards of service.

Time Division Multiplex is one of the methods we're investigating. Our engineering teams are using high-frequency pulse techniques to make every microsecond count.

As applied in telephony, multiplexing works like this: The speech paths of a person talking on the phone are first reduced to pulses. A single word then consists of millions of pulses. These pulses are released to the line at regular intervals by the opening and closing of a gate switch. Pulses are stored for microsecond intervals between releases.

By synchronizing the pulses of many voices, a large number of conversations can take place simultaneously on the same wire. In a multiplex telephone exchange, for instance, a speech wave is "sampled" as many as 50,000 times per second.

This is just one of the many phases of our work at General Telephone Laboratories, in providing R & D support for Automatic Electric and other affiliated manufacturing units of General Telephone.

. . . . . .

You are invited—If you are interested in any of these fields—Logical Circuit and System Design, Magnetic and other Memory Devices, High-Frequency Pulse Techniques, Semiconductor Research or Electrical and Electromechanical Engineering—there's a fine career opening for you at General Telephone Laboratories. Why not check into the opportunities our expanding organization offers? For specific information, write in confidence to Mr. Robert Wopat, President, General Telephone Laboratories, Northlake, Illinois.

GENERAL TELEPHONE LABORATORIES

Completely Revised, October 1956 Issue

Electric Power Distribution for Industrial Plants

(RED BOOK)

No. 952

The purpose of this publication is to bring to the attention of engineers, owners, and plant management the important features of well-designed electric distribution systems that result in satisfactory performance of utilization equipment and efficient operation of the plant; it covers the features of the electric distribution systems which are applicable to most types and sizes of industrial plants. It sets forth the elements of the distribution system both as to what to do to accomplish desired results and the reasons for them. It does not explain in detail how to accomplish the final results.

Basic information is included to determine the approximate load requirements of industrial plants, the type of distribution system, the distribution voltages, and voltage regulation, as well as information to assist the engineer in the selection of transformers, circuit breakers, relays, meters, fuses, cables, bus, and miscellaneous equipment needed in the design of an adequate electric distribution system for present and future load conditions. Operating and maintenance problems are dealt with only in so far as they affect system and equipment selection. Basic information is included to determine load requirements, type of system, and voltages. Data are included to assist selecting transformers, circuit breakers, relays, meters, fuses, conductor, and miscellaneous equipment for present and future loads.

$3.50 per copy (50 per cent discount to AIEE members); 172 pages

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Companion Publication (Also October 1956)

Grounding of Industrial Power Systems

No. 953

This publication covers the problems of system grounding, connecting the frames and enclosures of electric apparatus to a ground system, the problems of static, the methods of protecting structures against the effects of lightning, and the problems of obtaining a low resistance connection to the earth.

The popular name "Green Book" now applies to this new publication rather than to Interior Wiring Design for Commercial Buildings as before. The latter publication is out of print pending revision and when the new edition is available it will be known as the "Gray Book."

$1.20 per copy (50 per cent discount to AIEE members); 40 pages

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ENGINEERS

General Electric Announces Opportunities in Area of

BALLISTIC MISSILE DEFENSE ENVIRONMENTS

Wide Diversity of Positions Include D & D on Long-Range Surveillance Radar

These openings are with the Missile Detection Systems Section of G. E., designer and producer of what are believed to be the most powerful long-range radar detection systems in the world.

Current programs involve work on still more advanced systems —among them Ballistic Missile Early Warning Surveillance and other super radar systems to detect ICBMs as they rise over the horizon at distances up to several thousands of miles.

No technical area makes greater demands on the scientific skills and creative imagination of the engineer than Ballistic Missile Defense Environments.

Openings for engineers with 4-10, or more, years' experience in:

SYSTEMS DEVELOPMENT

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Computer Programmers

Openings for engineers with degree and 2 or more years' experience in:

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Qualified engineers will be invited to visit the Missile Detection Systems Section and judge at first hand the unusual opportunities offered for professional growth —and the excellent living conditions in-and-around Syracuse, New York. Please write in confidence to: Mr. James P. Kinsella, Div. 25 MR.

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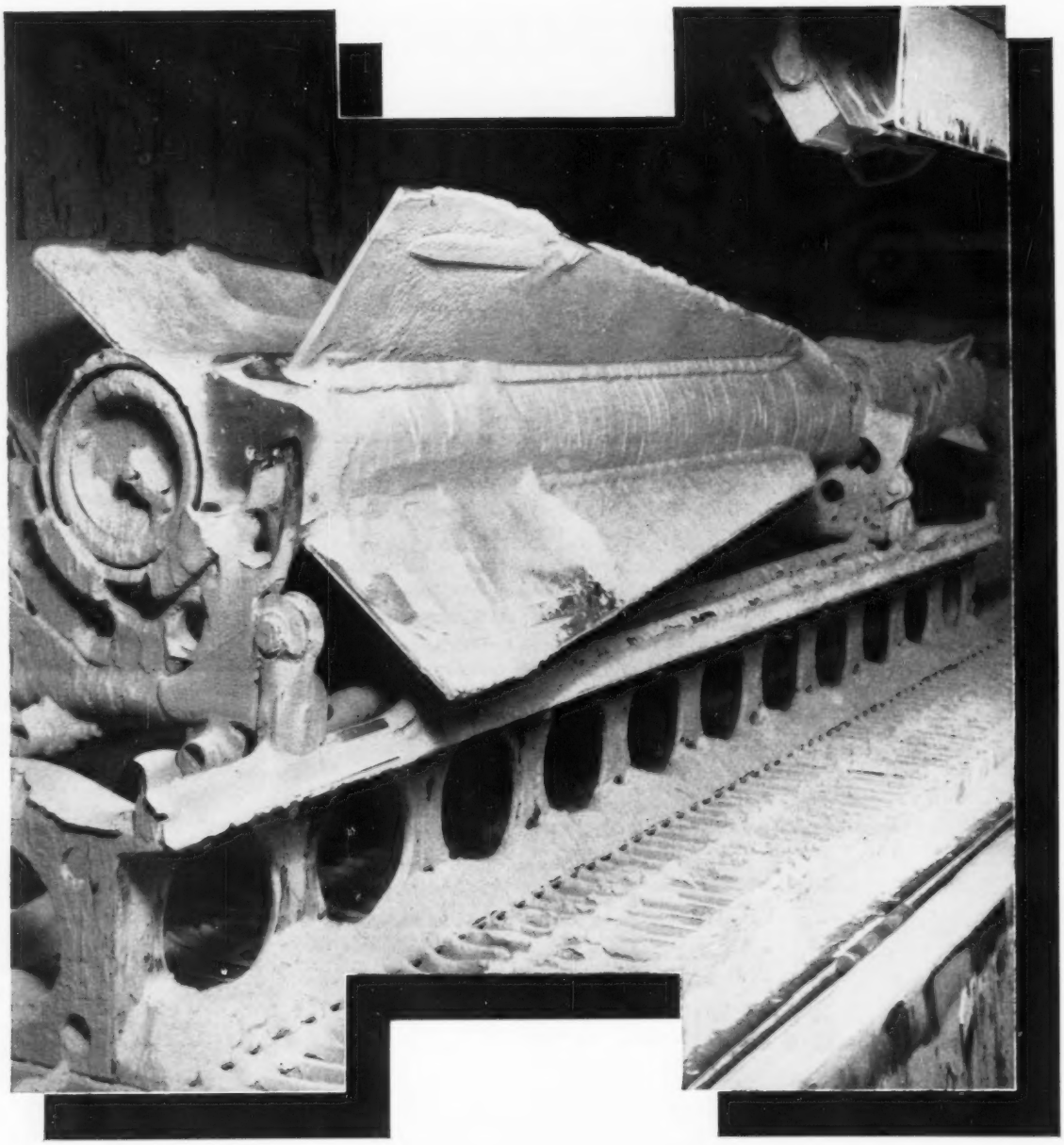
TRAINING A BIRD



TO NEST IN THE SAND

They try to "make life difficult"

The brittle cold of the stratosphere . . . the heat of air-skin friction . . . the acceleration and vibration of launch and flight . . . the unfavorable conditions inherent to storage and handling . . . all these factors can play havoc with a guided missile.

Hughes Research and Development engineers have designed the Falcon air-to-air guided missile to operate under the most severe conditions. Environmental testing (see Sand & Dust Test at left) subjects missiles to extremes in temperature, shock and other trouble-making conditions.

The Falcon missiles, with either infrared and radar guidance systems, measure only about 6½ inches in diameter. Complex guidance, control and auxiliary systems of each missile are installed in a space no bigger than a stovepipe.

The research and development skill required to successfully engineer the Falcons typifies the challenge present today in other Hughes guided missile assignments of a more classified nature. A few of the areas being emphasized by the Hughes Research and Development Laboratories include missile launchers and power plants, guidance systems, reliability, product design, microwaves, aerodynamics, field test and telemetering, stress analysis and related areas.

High orders of engineering skill are also manifest in other Hughes activities. The commercial area, Hughes Products, has recently announced the development of a numerical control system which will automate a complete and integrated line of machine tools. The Hughes Ground Systems Division has developed a radar antenna which provides three-dimensional target data from a single antenna, transmitter and receiving channel.

Apart from the diversity of activity and the highly rewarding type of work, prospective employees may have confidence in the fact that Hughes will retain its leadership in the field of advanced electronics.

Collapsing the time between missile development and its effective tactical use is a project assigned to the Hughes Tucson Engineering Laboratories.

So advanced is the test equipment being designed by Hughes engineers in the El Segundo Manufacturing Plant that the test equipment is often as complex as the advanced systems being tested.

A immediate need now exists for engineers in the following areas:

Circuit Design	Computer Engineering
Reliability	Crystal Filters
Communications	Microwaves
Environmental	Field Engineering
Vacuum Tubes	Aerodynamics

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-D, Culver City, California.

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Creating a new world with ELECTRONICS

HUGHES

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I HAD THE BOSS UP A POLE...

"He knew all about the operating advantages of polyethylene coated wire . . . but I took him up and showed him why *I* liked it and why it's saving the company even more money than he figured."

In the past 12 years polyethylene covered line wire and cable have chalked up outstanding service records for utilities. But some of the best reasons for using polyethylene coatings don't turn up in operating statistics — they come from the men whose job it is to install and maintain the lines . . . Reasons such as these:

Polyethylene Is Easier to Install

It's free stripping, yet has excellent adhesion and will not ruffle over cross arms. It's clean to work with and its surface is "slippery" too. Polyethylene coating is lighter than other types of covering . . . it handles easier.

Polyethylene Covered Line Wire Saves Outages

Polyethylene forms a complete and permanent covering over line wire. That means fewer outages from contact with trees, wind-blown swinging wires and foreign objects. Smaller diameter polyethylene coatings offer less wind resistance above ground. Lighter weight can be an advantage, too, in ice storms.

In field servicing . . . in over-all performance and service life—polyethylene has proved its superiority in wire and cable applications such as these:

- Line wire covering
- Power cable dielectric
- Tree wire covering
- GTO (Neon Sign) Cable
- Coaxial Cable
- WD-1 Infantry Field Wire
- Control cable insulation and jacket
- Communication cable insulation and sheaths
- Corrosion protection for metal sheaths.
- TV Lead Wire

When you order polyethylene covered wire and cable, ask your supplier about the superior weather and stress crack resistance of polyethylene made with PETROTHENE® polyethylene resins. PETROTHENE quality costs no more.

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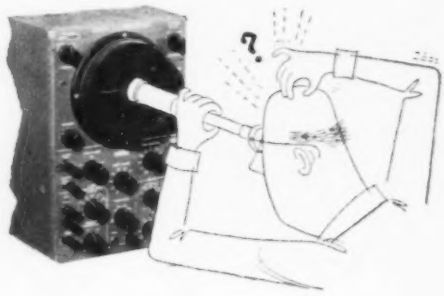
Makers of PETROTHENE Polyethylene Resins

JOURNAL OF APPLIED CONTROL DEVICES THAT NEVER WEAR OUT

For Control Engineers Who Are Wearing Out Before Their Time

WHEN A SIGNAL ALMOST ISN'T...



We feel like passing out cigars because our development engineers have given birth to a new addition to the CONTROL standard line of proportioning reactors that never wear out. It's a pre-amplifier that will work from a 200-microwatt signal, with a 3-cycle response. Hitch it to a CONTROL proportioning reactor and in one step you have wide range control of a 2-KVA load. That means if you have to work from the minute output of a small tach-generator, thickness gauge, electronic relay or process control instrumentation, you should write us. *We've got CONTROL pre-amplifier specifications ready for you.*

THE HECK WITH MAINTENANCE!

There are no moving parts in a CONTROL proportioning reactor. There are no filaments to burn out. There are no adjustments to make. You can bury them, fly them through the troposphere, or install them in the corrosive atmosphere of a chlorine plant—it makes no difference. If you're tired of control equipment that has to be pampered with maintenance, you're for us. Servicing? Parts replacement? No more, friend, no more. We're better than hormones for the pooped-out control engineer. *Why not write us your troubles?*

DESIGN CONTROL CIRCUITS WITH BUILDING BLOCKS...

When we took "never wear out" magnetic devices into the industrial control field, we made the grand plunge—designed standard lines which a systems engineer could design into his equipment right from the CONTROL catalog. That put an end to the high price of the unusual advantages of saturable reactors. Instead of custom designing, we mass produce—and your costs come tumbling down. *Want to select the building blocks to design your control circuits? We have information on CONTROL'S standard proportioning reactors—theory, characteristics, typical uses. It awaits your letter.*

Reliability begins with CONTROL

A DIVISION OF MAGNETICS INC

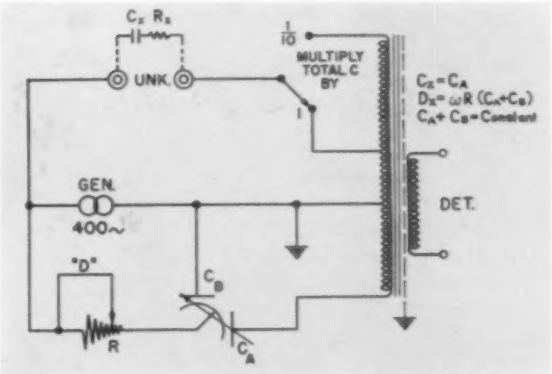
DEPT. EN-50, BUTLER, PENNSYLVANIA

Designed for guarded or 3-terminal measurements
Ruggedized null indicator.
Built-in 400-cycle oscillator
Dissipation-factor dial
Unknown C = C1 + C2. Scale length of C1 calibration is over 19 feet.
Panel lights indicate direction of bridge balance.

New Fully Militarized GR Type P-582 Capacitance Bridge

(Military Designation: Test Set, Capacitance Bridge, TTU-24/E, Precision, Three-Terminal, Depot)

. . . for accurate measurement of 3-terminal capacitance and dissipation factor at 400 cycles. This bridge with its many unique features is useful for general-purpose capacitance measurements, and is ideal for testing precise capacitance fuel-gage testers.



A transformer-type circuit is used to obtain precise 1:1 or 10:1 ratio arms with which to compare the unknown, C_x, against the internal standard capacitor. This standard is a special differential G-R Type 722 variable capacitor, plus a silvered-mica decade to extend the range to 11,000 $\mu\mu$f. The sum ($C_A + C_B$) is held constant, so that the variable resistor R may be calibrated in D directly.

The 400-cycle oscillator uses a thermistor-stabilized R-C Wein Bridge network in a three-stage feedback circuit. Frequency is virtually independent of tube parameter changes. The detector uses two cascaded, twin-T feedback amplifiers for high selectivity. Stray impedances from the unshielded and coaxial leads to chassis ground (third terminal) shunt oscillator and bridge transformer respectively and, therefore, cause negligible bridge errors.

UNIQUE FEATURES:

- Completely Self Contained . . . oscillator, bridge circuit, and null detector in one cabinet.
- Reads D directly, no calculation necessary.
- Null indicator has compressed response for easy balance.
- When null indicator is upscale, one of two panel lights indicates the direction of capacitance adjustment necessary (increase or decrease value of standard). If neither light operates with up-scale reading, then dissipation-factor adjustment must be made.

SPECIFICATIONS

Ranges:
Capacitance: 5 $\mu\mu$f to 0.011 μf
Dissipation Factor: 0 to 0.11

Accuracy:
Capacitance: Depends on setting of variable and fixed capacitors.
Variable Capacitor: on X1 Range, ±0.4 $\mu\mu$f or ±0.1%, whichever is greater; on X1/10 Range, ±0.04 $\mu\mu$f or ±0.1%, whichever is greater.
Decade Capacitor: ±0.1% on both ranges.
Dissipation Factor: ±2% of reading ±0.0002.

Detector Sensitivity:
X1 MULTIPLIER position — 10% deflection for 0.05 $\mu\mu$f ΔC.
X1/10 MULTIPLIER position — 10% deflection for 0.005 $\mu\mu$f ΔC.

Tube Complement:
Five 5751, 12AT7WA, 6X4WA.

Price: $2175.

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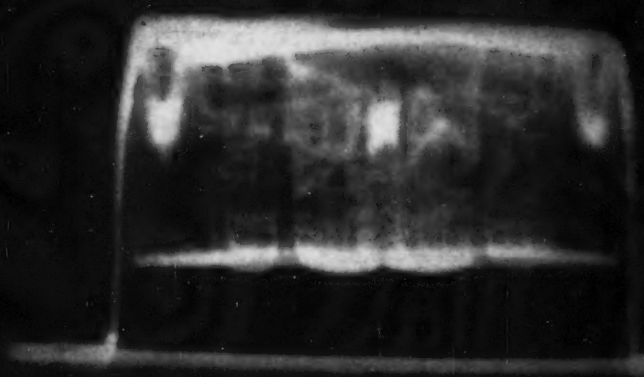
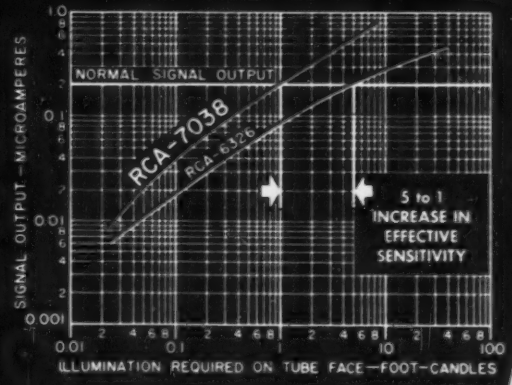


Waveform-Oscilloscope Pattern Showing Signal Output and Uniform Sensitivity of the RCA-7038.

RCA-7038 Vidicon Without Side Tip (tube shown actual size).

FOR NEW TV-CAMERA DESIGNS

New, Improved Vidicon ...with much higher effective sensitivity



RCA-7038 Provides Higher Effective Sensitivity in New Camera Design.

Designed for superior performance in broadcast, industrial, and military TV applications, RCA-7038 opens new possibilities in compact camera design for live and film pickup–both in color and black-and-white.

Here is a new Vidicon that can deliver broadcast-quality pictures–with as little as 1 foot-candle of illumination on its faceplate. An improved photolayer is capable of providing uniform sensitivity–over the entire scanned area. All "front-end" parts are non-magnetic to facilitate registration in three-vidicon color TV cameras.

RCA-7038 utilizes a 750-mesh screen. It has a resolution capability of 600 lines, and a spectral response covering the entire visible spectrum.

For a bulletin containing technical data and application information on the RCA-7038, write RCA Commercial Engineering, Section F-16-Q, Harrison, N. J.

Designers of TV cameras are invited to discuss their Vidicon requirements with their RCA Field Representative—at the nearest RCA Field Office:

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